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ABSTRACT

This report presents a summary of air training programs in junior colleges, vocational/technical training institutes, community colleges, four year colleges, and universities as well as other training institutions. It represents a sample, only, of the various programs available nationwide. Forty-five institutions located in 25 states were chosen for on-site visits. Enrollment and graduate statistics are given, as well as statistics on numbers of full- and part-time faculty. Various curriculum options used in the institutions are discussed. Finally, employment statistics are given. (Author/BB)

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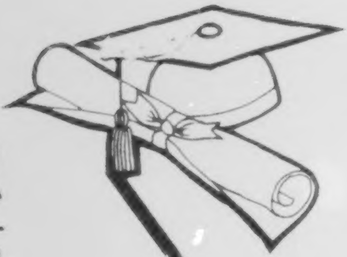

Post Secondary Education Profile

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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Phase II
Of A National Environmental/Energy Workforce Assessment

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.
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SE 025 198

NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT

PHASE II

POST-SECONDARY EDUCATION PROFILE

AIR

Conducted by:

NATIONAL FIELD RESEARCH CENTER, INC.

Under Grant from:

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INTRODUCTORY NOTE

The National Environmental/Energy Workforce Assessment: Post-Secondary Education Profile was conducted by National Field Research Center, Inc. with main offices in Iowa City, Iowa. The following personnel have had primary responsibility for the development of the project report.

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ACKNOWLEDGEMENT

Appreciation is extended to the many individuals, institutions, and organizations who generously contributed to the success of this national project. Of particular import are those contact persons listed in the program summaries. Their time and assistance in preparation, input and review represents the foundation upon which the National Environmental/ Energy Workforce Assessment - Phase II rests.

Sincere appreciation is expressed to those persons within the United States Environmental Protection Agency, Office of Federal Activities, who provided guidance and direction throughout the term of the project: Mr. J. Donald Cook, Project officer; Mr. Joseph McCabe, and Mr. Michael Moore. Special Thanks are also extended to Mr. Tahlman Krumm, Ohio State University and to Mr. Fred Stinson, Research Triangle Park.

Gratitude must be expressed to the many individuals and organizations from the private sector who were most generous in their contribution to this project. Their openness and responsiveness reflect their concern regarding the training of our environmental workforce and their critical role in that effort.

REVIEW COMMITTEE

A special word of acknowledgement is extended to the following people who graciously gave of their time, knowledge and experience in order to review and comment on the information included in this volume. The efforts of this national committee were particularly insightful, and in general have been incorporated into the final report.

It must be pointed out that in all cases the individuals acknowledged below were asked only to review and comment on the material contained in the volume and to express their views regarding the representativeness of the material presented. They were not asked to endorse either the volume or the study in general, and the inclusion of their name on this list should not be considered an endorsement since such was not the intent.

In light of numerous responsibilities, it is especially important to note that these persons responded within very strict time constraints. Such a pattern reflects positively on both the individuals and the institutions and organizations which they represent.

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FOREWORD

Information for this report was largely compiled from on-site interviews with professionals in post-secondary institutions throughout the United States. On-site interviews were supplemented by telephone and/or mail contact to clarify and revalidate the data. This report presents a summary of programs in junior colleges, vocational/technical training institutes, community colleges, four-year colleges, and universities as well as other training institutions. Programs are representative of all levels from academic certification through doctoral degrees. The environmental pollution control areas of air, noise, pesticides, potable water, radiation, solid waste, wastewater and energy were surveyed.

This study was conducted for the United States Environmental Protection Agency by the National Field Research Center, Inc. of Iowa City, Iowa, with field offices located in Atlanta, Georgia; Denver, Colorado; and Washington, D.C.

NATIONAL ENVIRONMENTAL/ENERGY WORKFORCE ASSESSMENT

PHASE II

POST-SECONDARY EDUCATION PROFILE

AIR

SUMMARY

AIR

A. STATES, INSTITUTIONS, PROGRAMS AND DEGREES

Forty five institutions located in 25 states were chosen for on-site visits. They are representative samples of air training programs available in the United States. Fifty programs are described in the program summaries section of the air volume; 48 at the various institutions and two non-degree programs (U.S. Environmental Protection Agency at Research Triangle Park, North Carolina and the Air Pollution Control Association in Pittsburgh, Pennsylvania).

Degrees offered by the 45 institutions varied from a minor to a doctoral. The following table shows the number of programs that were surveyed by degree and state.

AIR DEGREES, PROGRAMS AND STATES

Degrees	Number of Programs
Minor	1
Certificate	1
Associate	8
Bachelors	2
Masters	11
Environmental Engineer	1
Multiple - degrees	
Certificate/Associate	1
Bachelors/Masters	1
Bachelors/Masters/PhD	6
Masters/Engineer/PhD	1
Masters/PhD	15
TOTAL	48

States

Connecticut
Delaware
Florida
Illinois
Indiana
Iowa
Kentucky
Maryland
Massachusetts
Michigan
Missouri
New Jersey
New York
North Carolina
North Dakota
Ohio
Pennsylvania
South Carolina
Tennessee
Texas

B. ENROLLMENT STATISTICS AND GRADUATES

Techniques for the recruitment of students depends upon the institution. Methods that have proven to be very helpful include: alumni publications, articles in professional journals, mass mailings, open house, recommendation by a graduate, visits to area high schools.

Graduate level training (Masters & PhD) has more out-of-state students than are found in the associate & bachelor programs. In part, this can be attributed to more funding being available to students and to the fact that fewer institutions offer advanced training. Thirty-three percent of the program (16 of 48) mentioned students of foreign origin being enrolled in their programs.

Almost half (25 of 48) of the programs had an organized and, in many cases, a yearly method in which they maintain contact with their graduates.

The nationwide trend is that more students are enrolled in the Masters program both as full-time and as part time students. It follows that Masters programs have the largest number of graduates.

Depicted below is the national enrollment profile.

AIR ENROLLMENT PROFILE SUMMARY

REGIONS I - X

Degree	Enrollment Full-time/Part-time		Graduates Average # Per Year	Enrollment Change By Program Up / Down / Stable		
Associate	152	8	66	2	5	2
Bachelors	639	15	182	5	0	4
Masters	912	618	424	10	3	21
Engineer	3	0	2	0	0	1
Doctoral	119	28	37	3	2	18
TOTAL	1,825	659	711	20	10	46

C. FACULTY

Numbers of full and part-time faculty were determined by the individual institutions. Because there is some duplication of programs (i.e. a write-up appearing in more than one volume), it would be misleading to assume that the 531 full-time and 1655 part-time faculty, associated with the 48 programs teach only air courses. Rather they have a variety of environmental courses to conduct.

Faculty members keep up-to-date on new knowledge and discoveries in the air field through conferences, journals, professional meetings, lectures, contact with their recent graduates, publishing.

D. CURRICULA

An internship/applied study term is an option for obtaining a degree at some institutions. It varies in length and may or may not include financial reimbursement. It has been cited as the distinguishing characteristic of a program. Nineteen of the forty-eight programs had such an option available.

In forty-six percent of the programs visited, implimentation of a course took between one month and one year. A program took the same amount of time with a slightly higher percentage (50%) responding affirmatively.

In responce to a commonly leveled criticism that students trained in the environmental areas are weak in written and oral communication and financial management skills, contact people were asked how their institution responded to this need. Methods most often mentioned for remediation were: summer practicum, requiring a speech course, incorporating technical writing skills into present course structure, requiring basic management skill courses.

E. RESEARCH FUNDING AND SOURCES OF STUDENT FINANCIAL SUPPORT

Most of the 45 institutions surveyed were receiving or had received public and/or private monies for research. It varies with faculty interest, teaching load and amount of clerical help supplied how much outside funding is connected with a specific program.

Great concern was expressed at the withdrawal of EPA funds for air research and the student support that often resulted. As a result of the reduction of grants available, enrollment in these programs are on the decline.

F. EMPLOYMENT

Employment statistics were gathered from contact people and are the results of formal follow-up studies or estimates. The table shows the combined result of the 48 air training programs visited.

AIR EMPLOYMENT PROFILE - NATIONAL

	Private Sector				
Degree	Industry	Consulting	Combined	Government	Other
Associate	18%	17%	35%	30%	35%
Bachelors	36%	38%	74%	22%	4%
Masters	28%	29%	57%	37%	6%
Engineer		50%	50%	35%	15%
Doctoral	31%	29%	60%	36%	4%

Contact people were asked to enumerate occupations that they felt their graduates were qualified to fill. Mentioned most often were:

Degree Level	Occupations
Associate	Air Pollution Control Inspector Air Pollution Control Technician Pollution Control Specialist
Bachelor	Air Pollution Control Engineer Air Pollution Control Inspector Environmental Control Technologist
Masters	Air Pollution Control Engineer Air Pollution Control Superviser Chemist
Doctoral	Air Pollution Control Chemist Air Pollution Control Engineer Sanitary Engineer

PROJECT BACKGROUND

Photo reprinted from the University of Wisconsin, Madison Oceanography and Limnology Catalog

PROJECT BACKGROUND

OVERVIEW:

In late 1975, Congress acknowledged the growing national concern for the preservation and conservation of our national resources with a direct inquiry into the availability and readiness of our environmental workforce. That inquiry has taken the form of a three-year, three-phase National Environmental/Energy Workforce Assessment, currently being conducted by National Field Research Center under the direction of the U.S. Environmental Protection Agency. In keeping with the objective of the assessment, this three-phase national effort directs itself at environmental/energy workforce needs, national educational preparedness, and the functional relationship between the two.

PHASE I:

Phase I of the National Environmental/Energy Workforce Assessment focused upon the development of "workforce demand projections" through 1982 for all public environmental agencies. This on-site assessment, which was carried out in all 50 states, Puerto Rico and the Virgin Islands, culminated in a numerical profile of the growth patterns and workforce needs at the national and state levels. Stratification of the overall definition of "environmental occupation" into seven distinct vocational areas enhanced even further the applicability of the results. In addition to this public sector workforce assessment, Phase I included an overview analysis of private sector needs (through an adjunct mail survey of selected businesses and industries) and a brief review of selected environmental educational programs.

Phase I was completed in May, 1977. The 70-volume final report included:

* National Abstract	(1)
* National Legislation	(1)
* Regional Assessments	(10)
* State Assessments (including D.C., VI and PR)	(53)
* Business and Industry Assessment	(1)
* National Summary	(4)

PHASE II:

Phase II of the National Environmental/Energy Workforce Assessment was structured around an intensive on-site inventory of representative environmental educational offerings on a national scale. The primary objective of this project has been to collect and aggregate data on training and educational programs in both the post-secondary education field and in the private sector and to do so by environmental area. Specifically, the study was designed to provide an overview of environmentally related post-secondary education programs, their program structure, representative course offerings, employment history of the graduates, and the faculty structure. Additionally, information was to be collected on program requirements and program projections.

Initially, opportunities to nominate programs for inclusion in this on-site review process was given to the Environmental Protection Agency and its program officers and regional personnel both through the

Project Officer and via direct mail requests; all state departments of education; state environmental agencies and selected media-specific associations. These nominations were supplemented by a direct review of institutional catalogs, information obtained during the first year's on-site activities, and a review of other published sources of information regarding degree programs in environmental areas. These sources are included in Appendix III - Selected Bibliography.

Following their initial development, the lists of nominees were forwarded to the program officers for suggestions regarding additions or deletions. Next, letters were written to those nominated institutions seeking their support and cooperation in the on-site review process. Several programs, some of which were highly recommended, declined the opportunity to participate giving reasons varying from lack of time to the fact that the program being inquired about no longer existed, to outright refusal to cooperate with any government study. These institutions were deleted from the final on-site process. The remainder were included in the study and are shown in Table 1 of each volume. Selection of the sample for the private sector is discussed in depth in that particular volume.

In preparation for the on-site interviews, appropriate persons were contacted in the institution involved and were given a background description of the study, a suggested timetable for the interview process and were told what kind of information was being sought. This was all done in an effort to keep the time involvement of the individual contact persons at a minimum. During the actual on-site interview, generally lasting around one hour, the information was collected, questions asked and answered, and further informational contacts identified. Following this process, each on-site interview was written up in the form of a Training Program Summary, which where time allowed, was returned to the contact person for critiquing prior to inclusion in the report.

Throughout this process, individuals and institutions were given assurance that this study was not an attempt to evaluate program offerings and every attempt has been made on the part of the writers to live up to this assurance. Inclusion in this report provides no assurances of quality, nor should a program's exclusion be consideration of the lack thereof. In many instances certain programs within an institution were not included while others were, primarily due to the determination of the sample - previously discussed. This too should not be viewed in any qualitative manner.

REPORT ORGANIZATION:

The final report, of which this volume is a part, consists of volumes depicting a training profile in each medium under consideration, namely,

Air
Energy
Noise
Pesticides
Potable Water
Radiation
Solid Waste
Wastewater
Composite
Business and Industry and Trade Associations

At the outset it should be pointed out that there are very few degree programs conveying degrees in a particular medium; rather, degrees are offered in various specialties which lend themselves to obtaining employment in one or more of these fields. Nonetheless, to obtain maximum utility for the funding agency, programs were reported in this fashion. The Composite section was necessitated by the number of programs offering course work in multiple fields and differing specializations resulting from course selection. For convenience in handling of the data Potable Water, Wastewater and Composite have been reported in multiple volumes because of the numbers involved. Although separated into volumes either by degree level of the programs involved, as in the case of Potable Water and Wastewater, or by content as in the case of Composite, persons interested in any of these fields would be well advised to review each of the volumes to assure more complete coverage.

Along with the standard introductory pages common to volumes of this nature, each volume contains sections on Project Background, Introduction (consisting of sections devoted to a description of the programs surveyed and covered in the volume), Project Commentary, and the Training Summaries along with the Appendices.

REVIEW PROCESS:

In addition to individual training summary reviews conducted by the persons initially interviewed, each volume has been reviewed internally, by persons in the Environmental Protection Agency and by a select group of review committee members. In the final instance, individuals met during the on-site process were nominated by interviewers for inclusion on the review committee, primarily as a result of their obvious expertise in the field and their evidenced interest in the project.

These persons were then contacted by mail or by telephone in an effort to determine their willingness to serve. The rather stringent timelines necessary to keep the project on course and to deliver the finished product as specified were also detailed. In excess of one hundred persons returned their volumes (out of a mailing of 120) and all but five of these provided usable responses. In these five instances either last minute job demands prevented them from carrying out the review in the short timelines, or (in two instances) individuals indicated that they wanted nothing to do with the process. This particular method of review provided a wealth of valuable information, suggestions for revision of specific elements, and general comments helpful in revising the final documents. In all cases an effort was made to seriously consider and incorporate reviewer suggestions. The persons on the various review committees are individually acknowledged in the front of the volume they reviewed.

Photo reprinted from the University of Missouri, Columbia Bulletin 1977.

INTRODUCTION

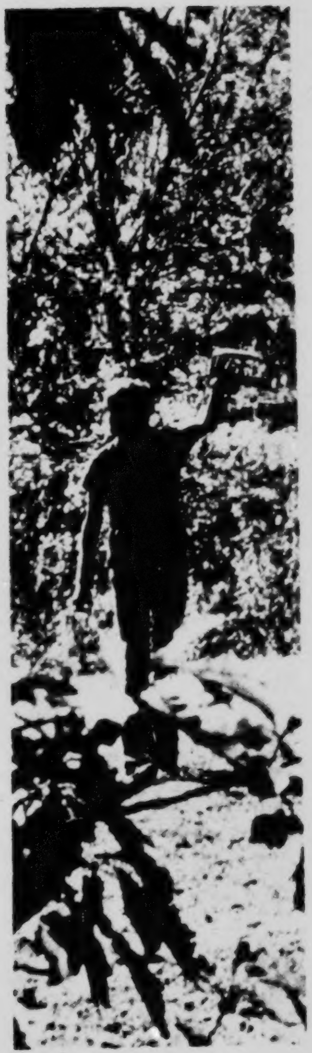

Photo reprinted from the Northland College Catalog 1975-76

INTRODUCTION

The National Academy of Sciences has stated that air pollution causes the death of many thousands of Americans each year. Medical experts now estimate that 70 percent to 90 percent of human cancer is caused by environmental factors, and the cancer rate has been rising each year.[1]

In the 1963 Clean Air Act Congress reaffirmed the policy of state and local responsibility for control, provided for many new activities authorized expanded research and continued local and state program support.

The problems of air pollution are complicated by our advanced technological society and the numerous classification of pollutants that result. This was recognized by EPA during its 1970 formulation with the resulting emphasis via training grants on air research during the late 1960's.

The Clean Air Act of 1970 changed the role of the federal government from one of limited authority to deep involvement in nationwide air pollution control. During the ensuing year, Air Quality Standards were formulated. There are primary standards (designed to protect the public health) and secondary standards (designed to protect the public welfare) which address the following items: sulfur oxides, particulate matter, carbon monoxide, photochemical oxidants, hydrocarbons, nitrogen dioxide. The Clean Air Act Amendments of 1977 (PL

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[1] Jimmy Carter, "My Views on the Environment", EPA Journal, January, 1977, p.6.

95-95) are the most recent federal legislation relating to air pollution.

The Post-Secondary Education Profile identified and gathered information concerning representative training programs in a variety of environmental areas: air, energy, noise, pesticides, potable water, radiation, solid waste and wastewater.

This volume is concerned with programs offering air training in the United States. Section I of this report refers to Table 8 and discusses each portion of the heading in greater depth. Section II is titled Additional Findings and is a compilation of information gathered during the on-site visits. Table 8 (page 72) shows the 45 institutions that offer air programs that were visited in 25 states. The air training summaries, beginning on page 103, include program descriptions which detail program strucutre and requirements; a faculty, student, and graduate profile; and a program projection commentary along with some course descriptions.

For a complete listing of all institutions and programs included in the Post-Secondary Education Profile, see Table 1 which follows.

TABLE I

PARTICIPATING INSTITUTIONS

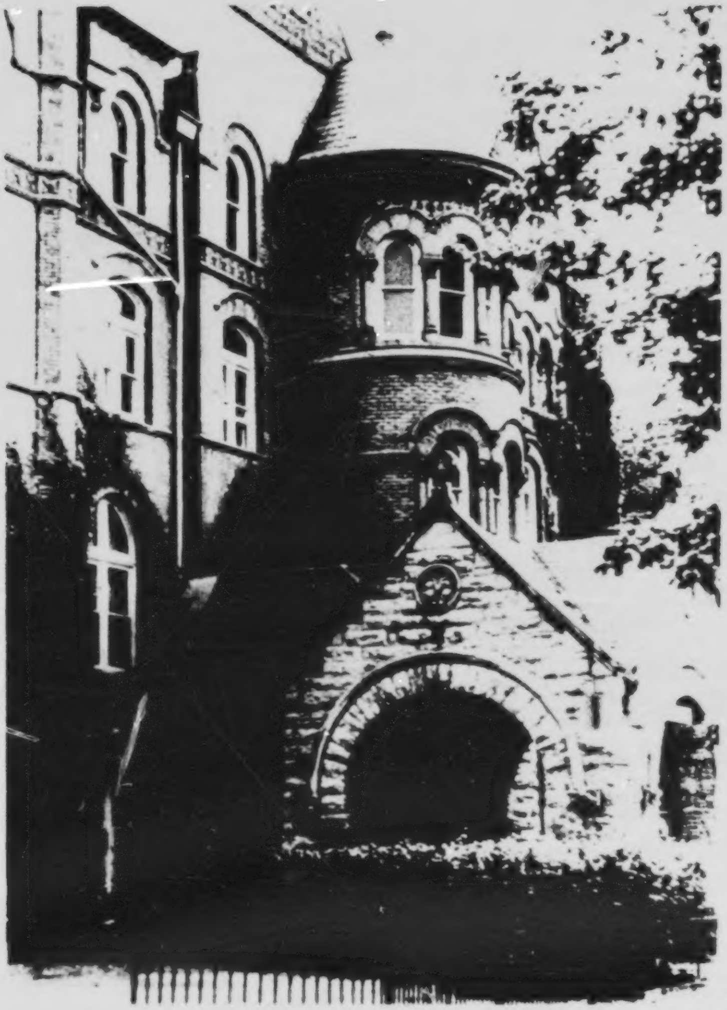

Photo reprinted from the Macalester College
1976-78 Catalog

Table 1 is a comprehensive listing of all institutions which participated in the post-secondary educational profile of the National Environmental/Energy Workforce Assessment. Listed by state, institution, and degree are programs surveyed in the areas of air, energy, noise, pesticides, potable water, radiation, solid waste and wastewater.

An explanation of the degree abbreviations utilized within the report may be found in Appendix I, entitled "Degree Abbreviations". For a complete listing of the institutions visited in a media specific area (i.e., air, energy, etc.), attention is drawn to Appendix IV, entitled "Participating Institutions by Environmental Category".

The Table in part III of the Project Findings, entitled "A Summary Profile of Representative Educational Programs" follows the narrative and is a presentation of specific institutions visited for the particular volume.

TABLE I

PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)*
AL	University of Alabama University	Environmental Engineering	M.S. (3)
AK	University of Alaska Fairbanks	Environmental Quality Engineering Science	M.S.
AR	University of Arkansas Fayetteville	Agricultural Engineering	B.S. M.S. Ph.D.
		Civil Engineering	M.S.C.E.
		Environmental Engineering	M.S.En.E.
		Environmental Science	B.S.
CA	California Institute of Technology Pasadena	Environmental Engineering Science	M.S. Ph.D.
	California Polytechnic State University San Luis Obispo	Environmental Engineering	B.S.
	California State University-Sacramento Sacramento	Civil and Environmental Engineering	B.S. M.S.
	Stanford University Stanford	Environmental and Water Studies	M.S. Ph.D.
	University of California-Berkeley Berkeley	Nuclear Engineering	B.S. M.S. M.E. Ph.D. D.E.
		Pest Management	B.S.
		Sanitary Engineering	M.S. M.E. Ph.D.
	University of California-Davis Davis	Environmental Toxicology	B.S.
		Plant Protection and Pest Management	M.S.

TABLE I

PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of California-Davis (Cont'd)	Entomology	B.S. M.S. Ph.D.
	University of California-Riverside Riverside	Pest Management	M.S.
	University of California-Santa Barbara Santa Barbara	Environmental Studies	B.A.
CO	Colorado State University Fort Collins	Environmental Engineering (Civil)	M.S. Ph.D.
	Community College of Denver-Red Rocks Golden	Water-Wastewater Technology	A.A.
CT	Hartford State Technical College Hartford	Nuclear Engineering Technology	A.S.
	Yale University New Haven	Environmental Health	M.P.H.
DE	Delaware Technical and Community College Newark	Environmental Engineering Technology	A.A.S.
	University of Delaware Newark	Entomology and Applied Ecology	B.S.
		Environmental Engineering	M.A.S. M.E. Ph.D. (App. Science) Ph.D. (ChE)
DC	Catholic University Washington	Civil Engineering	B.S.
	Howard University	Environmental Engineering	M.E.

TABLE I

PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
FL	Broward Community College Fort Lauderdale	Pest Control Technology	A.S.
	Central Florida Community College Ocala	Radiological Health Technology	A.S.
	Florida International University Miami	Environmental Studies	B.A. B.S.
		Environmental Engineering Technology	B.S.
	Heed University Hollywood	Ocean and Environmental Affairs	M.A. Ph.D.
	Miami-Dade Community College Miami	Environmental Engineering Technology	A.S.
		Marine Science Technology	A.S.
	University of Florida Gainesville	Air Pollution	M.E. M.S. Engineer Ph.D.
		Environmental Biology	M.E. M.S. Engineer Ph.D.
		Environmental Resources Management Activities	M.E. M.S. Engineer Ph.D.
		Systems Ecology	M.E. M.S. Engineer Ph.D.

TABLE I

PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Florida (Cont'd)	Water Supply and Water Pollution Control	M.E. M.S. Engineer Ph.D.
		Nuclear Engineering	B.S.(N.E.) B.S.E.(N.E.) M.E. M.S. Engineer Ph.D.
		Radiological Sciences	M.E. M.S.
	University of Miami Miami	Marine and Atmospheric Science	M.S. Ph.D.
GA	Abraham Baldwin Agricultural College Tifton	Plant Protection	A.Ag.
	Atlanta University Center/ Georgia Institute of Technology Atlanta	Water Pollution Control Design Engineering	B.S. B.E.
	Georgia Institute of Technology Atlanta	Acoustical Engineering	Advanced Cert.
		Energy Engineering	Advanced Cert.
		Environmental Studies	Advanced Cert.
	Southern Technical Institute Marietta	Nuclear Safety	A.S.
	University of Georgia Athens	Entomology	B.S. A.B. M.S. M.P.P.P.M. Ph.D.

TABLE I

PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Georgia (Cont'd)	Environmental Health Science	B.S.E.H.
HI	University of Hawaii Honolulu	Environmental and Sanitary Engineering	M.S.
IL	Illinois Institute of Technology Chicago	Environmental Engineering	B.S.E.S. M.S. Ph.D.
	Prairie State Community College Chicago Heights	Air, Water, Wastewater	A.A.S.
	Sangamon State University Springfield	Environments and People	B.A. M.A.
	Southern Illinois University-Edwardsville Edwardsville	Wastewater Treatment Operator Training	Cert.
IN	Indiana University Bloomington	Environmental Programs	Cert. A.S. B.A. B.S. M.P.A. M.S.E.S. Ph.D. (minor)
	Purdue University West Lafayette	Environmental Sciences Option	B.S.
		Nuclear Engineering	B.S.N.E. M.S. Ph.D.
IA	Iowa State University Ames	Environmental Studies	B.A. B.S.
		Sanitary Engineering and Water Resources	M.S. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Kirkwood Community College Cedar Rapids	Environmental Health Assistant	Diploma
		Environmental Health Technician	A.A.
		Water and Wastewater	Diploma
	University of Iowa Iowa City	Environmental Engineering	M.S. Ph.D.
		Environmental Toxicology	M.S. Ph.D.
KS	Kansas State University Manhattan	Chemical Engineering	B.S. M.S. Ph.D.
		Mechanical Engineering	B.S. M.S. Ph.D.
		Nuclear Engineering	B.S. M.S. Ph.D.
		Sanitary Engineering	M.S.C.E.
	University of Kansas Lawrence	Environmental Health Engineering	M.S. Ph.D.
		Environmental Health Science	M.S. Ph.D.
		Environmental Studies	B.A.
		Radiation Biophysics	B.A. B.S. M.S. Ph.D.
		Water Resources Engineering and Science	M.S. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
KY	Morehead State University Morehead	Environmental Studies	B.S. A.B.
		Mining Technology	A.A.S.
	Pikeville College Pikeville	Mining Technology	A.M.T.
	University of Kentucky Lexington	Energy (Coal) Engineering	M.S. Ph.D.
		Environmental Engineering	M.S. Ph.D.
	University of Louisville Louisville	Environmental Engineering	B.S. M.Eng.
	Western Kentucky University Bowling Green	Environmental Science	B.S.
		Environmental Engineering	B.S.
LA	Delgado College New Orleans	Urban Pest Management	A.S.
		Water/Wastewater Technology	A.S.
		Environmental Health Technology	A.S.
	McNeese State University Lake Charles	Environmental Science	B.S. M.S.
ME	Eastern Maine Vocational Technical Institute Bangor	Environmental Control Technology	A.A.S.
	New England Regional Wastewater Institute (S. Maine Vocational Technical Institute) S. Portland	Wastewater Treatment Technology	Cert.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Maine-Orono Orono	Sanitary Engineering	M.S.C.E. Ph.D.
MD	Charles County Community College La Plata	Pollution Abatement Technology	A.A.
	Johns Hopkins University Baltimore	Environmental Engineering	M.A. M.S.E. M.S. Ph.D
	University of Maryland College Park	Environmental Engineering	M.S.
		Nuclear Engineering	M.S.
		Pest Management	M.S.
MA	Harvard University Cambridge	Environmental Health Sciences	S.M. Sc.D.
		Environmental Sciences and Engineering	S.M. M.E. Ph.D.
		Toxicology	S.M. Sc.D.
	Massachusetts Institute of Technology Cambridge	Acoustics	S.M. Sc.D./ Ph.D.
		Environmental Engineering	Env.E.
		Mineral Resources Engineering and Management	S.M. Engr. Sc.D./ Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Massachusetts Institute of Technology (Cont'd)	Nuclear Engineering	S.B. S.M. N.E. Sc.D./ Ph.D.
		Water Resources and Environmental Engineering	S.B. S.M. Sc.D./ Ph.D.
		Wastewater Treatment Plant Operations	Cert.
	Northeastern University Boston	Environmental Engineering and Science	M.S.
	Springfield Technical Community College Springfield	Environmental Technician	A.S.
	Tufts University Medford	Environmental Health Engineering	B.S.C.E. M.S.
	University of Lowell Lowell	Radiological Health Physics/Radiological Sciences and Protection	B.S. M.S.
		Wastewater Treatment Plant Operations	Cert.
MI	Ferris State College Big Rapids	Environmental Health Technician	A.A.S.
		Environmental Health	B.S.
	Michigan State University East Lansing	Environmental Conservation Education	M.S. Ph.D.
		Environmental Engineering	B.S.C.E. M.S. (emphasis) Ph.D. (emphasis)

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Michigan State University (Cont'd)	Natural Resources and Environmental Education	B.S.
		Systems Science (Ecological Systems)	B.S. M.S. Ph.D.
	Michigan Technological University Houghton	Environmental Engineering	B.S.C.E. B.S.E. M.S.C.E.
	University of Michigan Ann Arbor	Environmental Education	M.S.
		Environmental Sciences Engineering	B.S.
		Industrial Hygiene and Air Pollution	M.P.H. M.S. Dr.P.H. Ph.D.
		Radiological Health	M.P.H. M.S. Dr.P.H. Ph.D.
		Water Resources: Engineering	M.S.E. Ph.D.
		Management Science	M.S. Ph.D.
		Water Quality	M.P.H. M.S. Dr.P.H. Ph.D.
MN	Bemedji State College Bemedji	Environmental Studies	B.S. M.A.
	Macalester College St. Paul	Environmental Studies	B.A. B.S.
	University of Minnesota Minneapolis	Environmental Health	M.P.H. M.S. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
MS	Mississippi State University Mississippi State	Specialized Training in Pest Management	M.Ag.
MO	Missouri Southern State College Joplin	Environmental Health Technology	A.S. B.S.
		Radiologic Technology	A.S.
	St. Louis Community College at Forest Park St. Louis	Radiologic Technology	A.S.
	University of Missouri-Columbia Columbia	Sanitary Engineering	B.S. M.S. Ph.D.
	University of Missouri-Rolla Rolla	Environmental and Sanitary Engineering	M.S. Ph.D.
	Water and Wastewater Technical School Neosho	Water and Wastewater Training	Cert.
	Washington University St. Louis	Air (emphasis)	M.S. D.Sc.
MT	Montana State University Bozeman	Environmental Engineering	M.S.
		Environmental Health Technology	M.S.
	Northern Montana College Havre	Environmental Health Technology	A.A. Cert.
NE	Central Technical Community College Hastings	Agriculture Technology	Cert. 1-Year Diploma 2-Year Diploma A.A.S. A.S.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Nebraska Lincoln	Sanitary Engineering	B.S. M.S. Ph.D.
		Water Resources Engineering	M.S.
		Planning and Management	M.S.
NH	University of New Hampshire Durham	Entomology	B.S. B.A.
NJ	Middlesex County College Edison	Environmental Health Science Technology	A.A.S.
	New Jersey Institute of Technology Newark	Interdisciplinary Studies in Environmental Engineering	M.S.
	Princeton University Princeton	Energy Conversion and Resources	Topical Programs
	Rutgers-SUNJ New Brunswick	Biology (option in entomology)	B.S. B.A.
		Entomology and Economic Zoology	M.S. M.P. Ph.D.
		Environmental and Business Economics	B.S.
		Environmental Science	M.S. Ph.D.
		Environmental Studies	B.S.
		Environmental and Water Resources Engineering	M.S. Ph.D.
		International Environmental Studies	B.A. B.S.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Rutgers-SUNJ (Cont'd)	Radiation Sciences	M.S. Ph.D.
	Stevens Institute of Technology Hoboken	Air Pollution Control Engineering	Cert.
		Water and Wastewater Engineering	Cert.
NM	New Mexico State University Las Cruces	Pest Management	B.S.
	University of New Mexico Albuquerque	Nuclear Engineering	M.S. Ph.D.
NY	Clarkson College Potsdam	Civil and Environmental Engineering	B.S. M.S.
	Columbia University New York City	Nuclear Engineering	B.S. M.S. Nuc.Engr. Eng.Sc.D.
	Cornell University Ithaca	College Program in Energy Conversion	B.S.
		Environmental Engineering	B.S. M.S. M.Eng. Ph.D.
		Waste Management Engineering	M.S. M.Eng. M.P.S. Ph.D.
		Nuclear Engineering	M.Eng. M.S. Ph.D.
	Hofstra University Hempstead	Solid Waste Management	Cert.
	Hudson Valley Community College Troy	Public Health Technology (Environmental option)	A.A.S.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Hunter College New York City	Environmental Health Science	B.S. M.S.
	Manhattan College New York City	Environmental Engineering and Science	M.S. M.E.
	Polytechnic Institute of New York New York City	Energy Engineering and Policy	Cert. M.S.
		Environmental Engineering and Planning	M.S.C.E. M.E.H.S. Engr. Ph.D.
	Rensselaer Polytechnic Institute Troy	Environmental Engineering	B.S. M.E. M.S. D.E. Ph.D.
		Nuclear Engineering	B.S. M.S. M.E. Ph.D.
	Rochester Institute of Technology Rochester	Civil Engineering Technology (Environmental option)	B.T.
	State University of New York-Buffalo Buffalo	Water Resources and Environmental Engineering	B.S. M.S. Ph.D.
	State University of New York Farmingdale	Pest Control Technology	A.A.S.
	Syracuse University Syracuse	Chemical Engineering	B.S. M.S. Ph.D.
		Environmental Engineering	B.S.
		Sanitary Engineering, Sanitary Science, Civil Engineering	M.S.(S.E.) M.S.(S.S.) Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	The Cooper Union New York City	Integrated Master's Program with concentration in Environmental Engineering	M.E.
	Ulster County Community College Stone Ridge	Water Quality Management Training	A.A.S.
	University of Rochester Rochester	Toxicology Training Program	M.S. Ph.D.
NC	Duke University Durham	Environmental Management	M.E.M.
		Civil Engineering/ Urban and Environmental Engineering	M.S. Ph.D.
	North Carolina State University Raleigh	Agricultural Pest Control	A.A.S.
		Pest Management	B.S. M.S. (minor)
		Air Conservation	M.S. (minor) M.E. (minor) Ph.D.(minor)
		Environmental Engineering	M.S. M.C.E. Ph.D.
		Acoustic, Noise Vibration	M.S. M.M.E. Ph.D.
	University of North Carolina Chapel Hill	Air and Industrial Hygiene	M.S. M.S.P.H.
		Environmental Chemistry and Biology	M.S. M.S.P.H. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of North Carolina (Cont'd)	Environmental Management Protection	M.S. M.S.P.H. Ph.D.
		Radiological Hygiene	M.S. M.S.P.H. Ph.D.
		Water Resources Engineering	M.S. M.S.P.H. M.S.E.E. Ph.D.
	Wilson County Technical Institute Wilson	Sanitary Landfill Operating Manager	Cert. Diploma A.A.S.
		Sanitary Landfill Technology	A.A,S.
ND	North Dakota State School of Science Wahpeton	Environmental Science Technology	A.A.
OH	Antioch College Yellow Springs	Environmental Studies	B.S.
	Hocking Technical College Nelsonville	Environmental Health Technology	A.A.S.
	Miami University Oxford	Environmental Science	M.En.
	Muskingum Area Technical College Zanesville	Environmental Quality Control Technology	A.A.S.
		Natural Resources Conservation Technology	A.A.S.
		Petroleum Engineering Technology	1-Year Cert. A.A.S.
	Ohio State University Columbus	Agricultural Engineering	B.S. M.S. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Ohio State University (Cont'd)	Chemical Engineering (air)	B.S. M.S. Ph.D.
		Civil Engineering	B.S. M.S. Ph.D.
		Environmental Biology	M.S. Ph.D.
		Environmental Education	B.S.(Ed.) B.S.(N.R.) M.S. Ph.D.
		Toxicology (Pharmacology)	M.S. Ph.D.
	Ohio University Athens	Environmental Studies	M.S.
	Raymond Walters General and Technical College (University of Cincinnati) Cincinnati	Environmental Control/ Protection Technology	A.S.
	University of Cincinnati Cincinnati	Air Pollution and Industrial Hygiene	M.S. Ph.D.
		Civil and Environmental Engineering	M.S. Ph.D.
		Environmental Health	M.S. Ph.D.
		Mechanical and Industrial Engineering (noise)	B.S. M.S. Ph.D.
		Occupational Medicine	M.S. Ph.D.
		Toxicology	M.S. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	University of Cincinnati (Cont'd)	Acoustics and Noise Control	B.S. M.S. Ph.D.
	University of Toledo Toledo	Chemical Engineering, Civil Engineering	B.S. M.S.
		Engineering Science	M.S.
OK	East Central Oklahoma State University Ada	Environmental Science	B.S.
	OSU Oklahoma City Technical Institute Oklahoma City	Civil Technology	A.S.
	Oklahoma State University Stillwater	Engineering Technology	A.D. B.S.
		Radiation and Nuclear Engineering Technology	A.D. B.S.
	Oscar Rose Junior College Midwest City	Wastewater Technology	A.A.S.
		Environmental Science	A.A.S.
	University of Oklahoma Norman	Environmental Science	B.S. M.S. Ph.D.
OR	Linn-Benton Community College Albany	Wastewater Technology	A.S.
		Water/Wastewater Technology	A.S.
		Water/Wastewater Plant Operator	Cert.
	Oregon Institute of Technology Klamath Falls	Environmental Technology	A.A.S. B.T.
	Oregon State University Corvallis	Nuclear Engineering Technology	B.S.
		Nuclear Engineering	B.S. M.S.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Oregon State University (Cont'd)	Pest Management and Plant Pathology	B.S. M.S.
	Portland State University Portland	Engineering and Applied Science	B.S. M.S.
PA	Carnegie-Mellon University Carnegie Institute of Technology Pittsburgh	Environmental Engineering	B.S. M.S. Ph.D.
	Drexel University Philadelphia	Environmental Engineering and Science	M.S.E.E. M.S.E.S. Ph.D.
	Pennsylvania State University University Park	Acoustics	M.E. M.S. Ph.D.
		Air Pollution Control Technology	A.A.P.C.T.
		Entomology	B.S. M.Agr. M.S. Ph.D.
		Environmental Engineering	B.S. M.S. M.E.E.E. Ph.D.
		Environmental Pollution Control	M.S. M.E.P.C. M.E.
		Environmental Resource Management	B.S.
		Minerals Processing	M.S. Ph.D.
		Mining Technology	A.A.S.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Pennsylvania State University (Cont'd)	Mining Engineering	B.S. M.S. M.E. Ph.D.
		Nuclear Engineering Technology	A.N.E.T.
		Nuclear Engineering	B.S. M.S. M.E. Ph.D.
		Petroleum and Natural Gas Engineering	B.S. M.S. Ph.D.
		Water Resources Engineering Technology	B.T.
	Slippery Rock State College Slippery Rock	Environmental Studies	B.S.
	Temple University Philadelphia	Environmental Technology	A.T.
		Environmental Engineering Technology	B.S.
	University of Pennsylvania Philadelphia	Energy Engineering	M.S.E.
		Energy Management and Policy	M.S.E.M.P. Ph.D.
	University of Pittsburgh Pittsburgh	Environmental and Sanitary Engineering	B.S. M.S. Ph.D.
		Environmental Systems Engineering	degrees granted through Engr. Dept.
	School of Public Health (University of Pittsburgh) Pittsburgh	Acoustic Environmental Control	M.S.(Hyg.) D.S.(Hyg.)
		Air Resources	M.S.(Hyg.)

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	School of Public Health (University of Pittsburgh) (Cont'd)	Environmental Health Engineering	M.P.H. D.S.(Hyg.)
		Environmental Health Planning	D.S.(Hyg.)
		Health Aspects of Water Quality	M.S.(Hyg.)
		Industrial Hygiene	M.S.(Hyg.)
		Toxicology	D.S.(Hyg.) Ph.D.
		Radiation Health	M.S.(Hyg.) D.S.(Hyg.) Ph.D. D.P.H.
RI	University of Rhode Island Kingston	Environmental Engineering	B.S. M.S. Ph.D.
SC	Clemson University Clemson	Air Pollution	M.S. M.Engr.
		Natural Systems	M.S. M.Engr.
		Planning and Management	M.S. M.Engr.
		Water Treatment Systems	M.S. M.Engr.
		Environmental Systems Engineering	Ph.D.
	Greenville Technical College Greenville	Wastewater Technology	A.A.S.
	Sumter Area Technical College Sumter	Environmental Engineering Technology	A.E.T.
TN	Chattanooga State Technical Community College Chattanooga	Environmental Science Technology	A.S.
		Nuclear Technology	A.S.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	East Tennessee State University Johnson City	Environmental Health	B.S.E.H. M.S.E.H.
	Memphis State University Memphis	Audiology	M.A. Ph.D.
	Middle Tennessee State University Murfreesboro	Environmental Science and Technology	B.S.
	State Technical Institute at Memphis Memphis	Environmental Engineering Technology	A.E.
	University of Tennessee Knoxville	Environmental Engineering	M.S.E.E. M.E. Ph.D.
		Environmental Engineering (Air Quality and Pollution Control)	M.S.E.E. M.E. Ph.D.
		Environmental Engineering (Water Pollution Control/ Water Resources)	M.S.E.E. M.E. Ph.D.
		Industrial Audiology	M.A.
		Nuclear Engineering	B.S. M.E. M.S. Ph.D.
		Water Resources Development	M.S.
	Vanderbilt University Nashville	Environmental and Water Resources Engineering (EWRE)	B.E.
		Environmental Science	B.S.
		EWRE (Environmental Science)	M.S. M.Eng. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
	Vanderbilt University (Cont'd)	EWRE (Air Resources)	M.S. M.Eng. Ph.D.
		EWRE (Solid Waste)	M.S. M.Eng. Ph.D.
		EWRE (Water and Wastewater Treatment/Water Resources)	M.S. M.Eng. Ph.D.
TX	Baylor University Waco	Institute of Environmental Studies	B.A. B.S.
	Lamar University Beaumont	Environmental Science	B.S.
		Energy Resource Management	B.S.
	Rice University Houston	Environmental Science and Engineering	M.S.
	Sam Houston State University Huntsville	Environmental Science	B.S.
	Texas A & M University College Station	Environmental Engineering	M.S. Ph.D.
		Entomology	M.S.
		Entomology/Pest Management Option	M. Ag.
	Texas State Technical Institution Waco	Nuclear Technology	A.A.S.
		Water/Wastewater Technology	A.A.S.
		Water Utility Operator	Certificate
	University of Texas Austin	Environmental Health Engineering	M.S. Ph.D.
		Water Resources Engineering	M.S. Ph.D.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
UT	Brigham Young University Provo	Chemical Engineering	B.S. M.S.
		Water Resources and Environmental Engineering	B.S. M.S.
	University of Utah Salt Lake City	Civil Engineering	B.S. M.E. M.S. Ph.D.
	Utah State University Logan	Civil and Environmental Engineering	B.S. M.S. Ph.D.
		Pest Management	B.S. M.S.
		Environmental Studies	B.S.
VA	George Washington University NASA-Langley Institute Hampton	Acoustics	M.S. Sc.D.
		Environmental Modeling	M.S.
	J.Sargeant Reynolds Community College Richmond	Environmental Technology Environmental Operations	Cert. A.A.S.
		Ground Water Resources	Cert.
	Virginia Polytechnic Institute and State University Blacksburg	Civil Engineering Technology	B.S.
		Sanitary Engineering/Environmental Sciences and Engineering/Civil Engineering	M.S. Ph.D.
	Wytheville Community College Wytheville	Environmental Technology	Cert.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
WA	The Evergreen State College Olympia	Coordinated Studies	B.A.
	University of Washington Seattle	Environmental Studies	B.A. B.S.
		Air Resources	M.S. Ph.D.
	Washington State University Pullman	Environmental Science	B.S. M.S.
		Chemical Engineering	M.S.
		Air Pollution Control Engineering	M.S.
		Air Pollution Science	M.S.
		Air Pollution Option	M.S.
		Air Pollution Program	M.S.
	Western Washington University Bellingham	Environmental Studies	B.S.
WV	Bluefield State College Bluefield	Mining Engineering Technology	A.S. B.S.
	West Virginia Institute of Technology Montgomery	Mining Engineering Technology	A.S.E.M.T. B.E.M.T.
	West Virginia University Morgantown	Engineering of Mines	B.S.
		Environmental Engineering	M.S.C.E. M.S.E.
		Mineral Processing Engineering	B.S. M.S.
		Mineral Resource Economics	M.S.
		Petroleum Engineering	B.S. M.S.

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PARTICIPATING INSTITUTIONS

STATE	INSTITUTION	PROGRAM TITLE	DEGREE(S)
WI	Marquette University Milwaukee	Environmental Engineering	B.A. B.S.
	Northland College Ashland	Environmental Studies	B.A.
	University of Wisconsin-Green Bay Green Bay	Environmental Emphasis	B.A. B.S. M.E.A.S.
	University of Wisconsin-Madison Madison	Civil and Environmental Engineering	B.S.
		Environmental Communications	M.A. M.S.
		Water Resources Management, Environmental Monitoring, Land Resources	M.S. Ph.D.
	University of Wisconsin-Milwaukee	Atmospheric and Marine Environmental Program	M.S. M.E.
WY	Casper College Casper	Water Quality Technology	A.S.
	University of Wyoming Laramie	Civil Engineering	M.S. Ph.D.

Other Programs

The following programs were included in the on-site visit process and offer training through various institutes, centers, state agencies, or college consortiums. Program descriptions can be found in the volume specified.

State	Institution	Program	Volume
FL	Florida Department of Environmental Regulation	Environmental Noise Control Training	Noise
	Miami-Dade Community College	NPDES Effluent Monitoring Training	Wastewater I
		Wastewater Treatment Plant Operations	Wastewater I
		Water Treatment Plant Operations	Potable Water I
	University of Miami School of Medicine	Pesticide Protection	Pesticides
KS	Kansas State University	Institute for Environmental Research	Composite II III Business and Industry
MI	Michigan State University	Institute of Water Research	Potable Water I
		Pesticide Research Center	Pesticides
NE	University of Mid-America	Pests, Pesticides and Pesticide Safety	Pesticides

State	Institution	Program	Volume
NJ	Princeton University	Environmental Science and Policy	Composite I
NC	U.S. Environmental Protection Agency	Air Pollution Training Institute	Air
OH	Ohio State University	Center for Lake Erie Area Research	Potable Water I
		Cooperative Extension Service Activities	Composite II and III
		Water Resources Center	Potable Water I
PA	Air Pollution Control Association	Refresher, Continuing Education Courses	Air
	University of Pittsburgh	Environmental Systems Engineering	Composite I
TN	Memphis State University	Nuclear Reactor Fundamentals	Energy
		Radiation Technician Training Course	Radiation
	Oak Ridge Associated Universities	Radiation Emergency Assistance Center/ Training Site	Radiation
		Special Training	Energy Radiation
	University of Tennessee Center For Health Sciences	Training Courses in Audiometric Orientation	Noise

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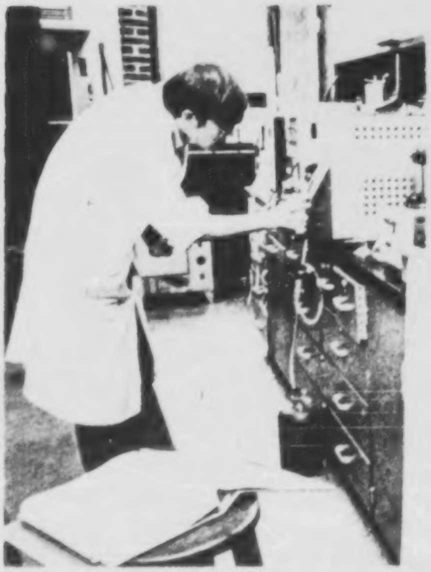
PROJECT FINDINGS



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I. A SUMMARY PROFILE OF REPRESENTATIVE AIR EDUCATIONAL PROGRAMS

A. States, Institutions, Programs and Degrees

Phase II looked at air training programs in 25 states and at 45 institutions varying in size and description from degrees offering minors to doctoral programs. This report contains detailed information, gathered from various sources and includes on-site interviews for 48 air training programs and two programs not offering degrees (U.S. Environmental Protection Agency at Research Triangle Park, North Carolina and the Air Pollution Control Association in Pittsburgh, Pennsylvania). Selection of these programs was based on a variety of factors and included: information and recommendations obtained during the workforce assessment phase of this project (Phase I); a review of the institution's program catalog; a review of other published sources of information regarding degree programs in environmental areas. There were no efforts on the part of the project staff to incorporate every program in every state.

On-site visits and extensive interviews were conducted to explore each of these 50 programs. Many of the institutions visited had programs in several environmental areas (e.g., industrial hygiene and air pollution or atmospheric and marine environmental programs). The reader is reminded that an asterisk (*) denotes that the program is listed in another volume(s) of this series. The information is duplicated in some cases and not meant to misrepresent the exact number of institutions working only in air. There is some overlapping of programs.

Table 8 lists the institutions visited, what program is offered there, and the degree(s) that is granted. As similar titles do not indicate similar programs, there has been no tabulation of program titles.

These 45 degree programs can be broken down in the following manner according to the degrees offered:

1	Minor
2	Certificate
9	Associate
10	Bachelors
50	Masters
2	Environmental Engineer
1	Engineer
24	Doctoral

Many institutions (31) offer multiple degrees; thus, the total number of degrees granted exceeds 48. Environmental Engineer/Engineer is a professional degree which goes beyond the masters level but does not have the research emphasis of the doctoral.

B. Enrollment Statistics and Graduates

The range of daytime enrollments was found to be:

Degree	Full-Time Enrollment	Part-time Enrollment
Associate	8-45	0-4
Bachelors	35-130	3-12
Masters	3-200	5-69
Env. Engr/Engr.	0-3	0-2
Doctoral	1-15	2-6

Only one institution (Northeastern University) was visited that has a large evening program and the 1977-78 enrollment was 245 students.

The range of graduates was found to be:

Degree	Number
Associate	3-20
Bachelors	4-34
Masters	1-40
Env. Engr./Engr.	0-2
Doctoral	1-3

These numbers are misleading, though, because of the inability to determine exactly how many students are in an air option at a particular institution. Many institutions do not ask for this determination until the student is graduating and the noting of a speciality is needed for transcript and diploma purposes. The majority of students are males although women are enrolling in more programs and presently about 10% are females. There is a small number of minority students. This recruitment has not been as successful as many contacted people would liked it to have been.

Table 2 is the enrollment profile summary of the 45 institutions visited. Up/Down/Stable refers to the increasing, decreasing or stable nature of the number of graduates in these programs. The nationwide trend is that the majority of students are enrolled in the masters programs both as full-time and as part-time students. The degree with the largest number of graduates is the masters. The 48 programs surveyed showed that graduates are remaining stable.

TABLE 2

AIR ENROLLMENT PROFILE SUMMARY

Degree	Enrollment Full-time/Part-time		Graduates Average # Per Year	Enrollment Change by Program Up/Down/Stable		
	Full-time	Part-time		Up	Down	Stable
Associate	152	8	66	2	5	2
Bachelors	639	15	182	5	0	4
Masters	912	618	424	10	3	21
Engineer	3	0	2	0	0	1
Doctoral	119	28	37	3	2	18
TOTAL	1,825	659	711	20	10	46

C. Student Origin

In the 48 training programs visited, the majority of students came from the state where the institution is located on the associate and bachelors level. There is conjecture that since associate programs are shorter in length, students are more likely to remain within commuting distance of their home. In the same thought, on the bachelors levels, students are most likely to remain within their home state to avoid higher tuition costs due to out-of-state tuition costs.

Graduate programs more often found the students coming from out-of-state. This change can be attributed largely to assistantships, fellowships, and other types of financial supports available. Also, fewer institutions are providing training at the masters and doctoral levels. Only 16 of the 48 programs (33%) listed any students of foreign origin.

D. Employment

At present, the student follow-up network does not readily provide for the categorization of the institution's graduates into distinct vocational roles. Although specific entry level positions are often known, most institutions limit their graduate occupational profiles to "government", "industry", and "consulting".

Table 3 provides graduate employment percentages for individual programs in four categories: industry, consulting, government, and other. These figures were provided by faculty members as facts or as estimates. The column entitled "Graduate Follow-Up" in Table 8 serves as an indicator of the employment figures' reliability, i.e., if follow-up is not carried out by a program, the employment figures must be regarded as estimates that were made by faculty members.

The data in Table 3 were compiled for each degree level by utilizing the average annual graduates figures within each program supplied by contact people, applying the employment percentages to these numbers and thus obtaining employment figures in real numbers. These real numbers for each program were then added and reworked into total percentages.

TABLE 3

AIR EMPLOYMENT SUMMARY

Degree	Private Sector			Governmental	Other
	Industry	Consulting	Total		
Associate	18%	17%	35%	30%	35%
Bachelors	36%	38%	74%	22%	4%
Masters	28%	29%	57%	37%	6%
Engineer	-	50%	50%	35%	15%
Doctoral	31%	29%	60%	36%	4%

Students who receive an associate degree most often gain employment in government positions. These positions are with local, state or federal agencies Bachelors degree recipients appear in the private sector, to be almost evenly divided between industry and consulting. Masters students (57%) gain employment in the private sector and over a third (38%) are employed in government. Doctoral students often gain employment with universities in teaching and/or research positions. The "other" category refers, in many cases, to the continuation of education (i.e., working for a higher degree).

The readers attention is also drawn to the employment portion of Table 8 - private, government, other. The private sector is divided into two parts (industry and consulting). In this context, consulting is referred to as either employment with a consulting engineering firm or working as an independent consultant.

Data for the employment of the graduates of various institutions is given in greater detail in Table 8, "A Summary Profile of Representative Air Training Programs."

A discussion of specific occupations graduates of these programs enter, in the public and private sectors, may be found in the II. Additional Findings (E. Environmental Occupations) section of this report.

E. Faculty

The numbers for full-time and part-time faculty were provided by the various institutions. No standard manner is employed by the training institutions to determine what constitutes a full-time or part-time faculty. It varies with each college or university. Thus, it is conceivable that a full-time person at one place would be classified as part-time at another. In areas in which the faculty number is very large, the reader is reminded that students can take courses from a variety of faculty members who do not teach environmentally related courses every semester or even on a regular basis. Some institutions have not developed separate departments for environmental offerings but rather have chosen to expand within the existing framework.

Although a student-faculty ratio could be developed, it would be less than meaningful because:

1) some faculty members are engaged primarily in research;
2) a variety of departments supply faculty for occasional courses;
3) in addition to their regular course load, faculty members teach an overload (additional courses);

4) programs with asterisks (*) are listed in more than one volume and faculty in these cases teach courses covering many subjects, not just those that directly relate to air.

F. Internship/Applied Study Terms

This section of Table 8 refers to an option for obtaining a degree. These internships/applied study terms vary in length (a few hours a week to a semester full-time) and there may or may not be some form of financial reimbursement involved. It depends on the institution as to whether the students find the internship/applied study on their own or through an office created to act as a clearinghouse at the particular institution. This experience has been singled out as the most important component distinguishing one program from another with similar course content. It is felt to be an essential step in the development of a well-qualified graduate. It should be noted that those students who have participated in an internship or applied study term have a measurable advantage in the job market over people who have no practical experience. Most programs cited examples of students who, upon graduation, have been offered full-time positions with the firm or agency with which they had interned.

Of the 48 programs, 19 did and 29 did not have an internship/applied study term available.

G. Graduate Follow-up

Twenty-five of 45 degree institutions have an organized manner in which they maintain contact with their graduates. For those institutions with engineering programs, follow-up reports are conducted for

Engineering Council for Professional Development (ECPD) and included in the report. It varies with the institution as to who does the actual data gathering. In some, it is carried out within a specific department. In others, it is the responsibility of the placement office. Alumni associations, honorary societies and annual department mail surveys are three means frequently reported for graduate follow-up. At some institutions questionnaires and newsletters have proven to be very effective.

An additional consideration is that many contact people could enumerate the initial placement of their graduates but were not able to chart their graduates career ladders. Training grants often require follow-up but once the monies are discontinued, the information is no longer gathered.

H. Non-Institutional Programs

Two institutions were surveyed that do not offer degrees. A brief discussion of each follows.

The Air Pollution Control Association, located in Pittsburgh, Pennsylvania sponsors both continuing education and refresher courses to professionals in the field during their annual meetings. Short courses are developed to meet the varying needs of the Association's membership and are offered through the year at various locations. A more detailed discussion can be found in the section of this report titled Air Program Summaries.

The U.S. Environmental Protection Agency (EPA) has had responsibility for the management of training and technical information services in air pollution control for EPA, and state and local air pollution control agencies since the formation of EPA in 1970. These activities are carried out within the Manpower and Technical Information Branch (MTIB) of the Control Programs Development Division, Office of Air Quality Planning and Standards at Research Triangle Park, North Carolina.

Direct training by the MTIB is carried out through the Air Pollution Training Institute (APTI). Presently, twenty different courses are offered by APTI staff and contractors. Other services available are self-instructional packaged courses, instructional resource materials and workshops. A more in-depth discussion of the organization and course descriptions can be found in the section titled Air Program Summaries.

II. ADDITIONAL FINDINGS

A. Recruitment Techniques

Types of recruitment techniques mentioned by various schools were:

somewhat helpful:

- posters to other schools with tear-off cards
- brochures

good:

- letters to outstanding undergraduates throughout the southeast
- seminars at other universities
- brochures to engineering programs across the United States
- announcements within the institution itself

very helpful:

- publicity from government agencies where various grants are awarded
- alumni publications
- faculty visits to area high schools
- mass mailings to area high school science teachers
- open house
- articles in professional journals
- meetings

Other means to disseminate information concerning the programs are:

- mailing information on course offerings to state and local air pollution personnel
- television and radio announcements
- Peterson's Guide to American Colleges and Universities

For graduate programs, drawing from the undergraduation portion of the school is another means of recruitment that has proven to be successful.

Some institutions because of their reputation and/or proximity to federal training institution do not find a need to maintain a specific recruitment program. Students seem to be drawn to the program. Others feel that unless you can offer some form of student support "It is a losing battle" and that you shouldn't bother to do formal recruitment. Referral by previous graduates to people they come into contact with is an informal means of recruitment that schools have found very successful.

Also offering programs at a time that is convenient for the students (e.g., evening) has a large drawing power. Although only one institution has a large evening enrollment, many offer late afternoon or evening classes. This enables the student to remain employed (in most cases full-time) while she/he is pursuing coursework.

B. Research Funding and Sources of Student Support

Some institutions have formal mechanisms for the writing of public and private grants. Performance of clerical duties enables the writer to direct his/her energies to the actual narrative ideas and research necessary for a quality product.

Sources of research funding most often mentioned were:

- Environmental Protection Agency Research Grants,
- National Science Foundation Grants,
- State departments of Health and Environmental Control.

Other sources were:

- National Institute of Occupational Safety and Health (NIOSH),
- Department of Energy (formerly the Energy Research and Development Administration),
- U.S. Corps of Engineers,
- Air Force,
- Occupational Safety and Health Administration (OSHA),
- National Pollution Discharge Elimination System (NPDES),
- National Atmospheric and Science Administration (NASA),
- American Society for Health and Engineering,
- National Institute for Environmental Health Sciences training grants.

Private money has also brought in research funding and, in turn, has been a source of student support. Some have been:

- Navy research grant,
- General Motors research grant,
- Private research grants,
- Chlorine Institute,
- General Foods Corportation,
- Florida Sugar Cane League,
- Rubber industry,
- American Iron and Steel Institute.

Some graduate institutions do not provide funding for students in their initial year of schooling. This makes it hard to attract students and, in addition, makes it difficult to place students on projects with private monies. They may leave before the project is completed.

Although student support is often tied to public and private monies, other forms of financial support were mentioned by everyone. They include state instructional grants, state and national student loans, Basic Educational Opportunity Grants, research assistantships, fellowships, scholarships.

Although not directed solely to air programs, many co-op programs exist in which students alternate semesters of school and work. This enables them to gain experience and money for expenses. Penn State is one of 13 schools which has an EPA Special Air Pollution Student Loan Fund available. It is available through the Center for Air Environment Studies. If a student works in the air pollution field for two years after graduation, the loan does not have to be repaid. (See the Air Training Summaries section, for more detailed information.)

C. Use of ERIC and IRIS

ERIC (Educational Resources Information Center) and IRIS (Instructional Resources Information System) are federally maintained computer retrieval systems encompassing educational resource materials on a national scale. IRIS is an Environmental Protection Agency generated compilation of information and although its chief focus is potable water and wastewater, faculty sources in each program area were questioned regarding its use.

Since the effectiveness of any such system can be measured by its application and use, Phase II was appropriately expanded to include an adjunct assessment of the "utilization profile" of the educational community.

It should be pointed out that the respondents to the assessment question, "Have you ever used ERIC or IRIS?" were faculty rather than students and that the findings contained in Table 4 should be interpreted accordingly.

TABLE 4

ERIC/IRIS UTILIZATION PROFILE - AIR

	Yes	No	Total Responding
ERIC	7	38	45
IRIS	5	40	45

Of all the environmental areas surveyed in Phase II (air, energy, noise, pesticides, potable water, radiation, solid waste, and wastewater), Table 5 depicts the national summary responses regarding the utilization of ERIC and IRIS.

TABLE 5

ERIC/IRIS UTILIZATION PROFILE - NATIONAL SUMMARY

	Yes	No	Total Responding
ERIC	72	307	379
IRIS	64	314	378

Nationally, of the 378 responses relative to the use of ERIC, 19% utilize the system, while 81% do not. Of the 377 responses regarding IRIS, 17% responded in the affirmative, and 83% reported that they do not use the IRIS system. From the above table, it may be noted that neither information retrieval system is widely utilized by the personnel interviewed.

The Air Pollution Technical Information Center (APTIC) is a computerized literature search located at Research Triangle Park, North Carolina. It is a data base of more than 80,000 citations that are selected, indexed, and abstracted in a manner relevant to the needs of the national air pollution control community. No programs surveyed mentioned a use of this service.

Other means of information retrieval were:

- department library
- Public Health Information System
- North Carolina Board of Science and Technology data files

Comments pertaining to retrieval:

- "EPA system of dissemination of materials used to be good but it has deteriorated tremendously."
- "Used to but 'they stopped sending the microfishe'".
- "Public Health Service had a good system with mailing lists, etc. and EPA used to be good when it took over the Public Health system; now publications and reports are difficult to get and information distribution is lousy."

D. Curriculum Flexibility

Phase II researchers, in an effort to compile data relative to the procedural, administrative, and developmental constraints in the modification of curriculum materials, posed the following question to contact people: "What is the time required to implement a complete content change in a course?"

A course for purposes of this study was defined as a new offering of subject matter. It is considered a unit of a program, in which a body of knowledge is presented, the satisfactory completion of which leads to the awarding of a predetermined or individually arranged number of credits. In many cases a course can be implemented in a short period of time and with a minimal amount of administrative paperwork. Institutions often have a mechanism that enables a professor to offer a course under "special projects".

TABLE 6

TIME REQUIRED TO IMPLEMENT A COMPLETE CONTENT CHANGE IN A COURSE

Degree Program	Less than 1 month	1 month-1 year	more than 1 year; less than 2	2-4 years	more than 4 years	Undetermined
Associate	3	4	0	0	0	1
Bachelors	3	3	0	1	0	2
Masters	5	12	1	1	0	9
Engineer	1	2	0	0	0	0
Doctoral	2	9	0	0	0	6
TOTAL	14	30	1	2	0	18

Table 6 shows that 46 percent of the programs (30 of 65) are able to implement a course in one month to one year; twenty-one and a half percent (14 of 65) in less than one month. Three percent (2 of 65) need two to four years; one and a half percent (1 of 65) find more than one year but less than 2 years adequate. Twenty-eight percent (18 of 65) were undetermined.

For the purposes of this study, a program is considered a course of study, either completely prescribed, or containing options, with an identity of its own and standard rules and procedures, the satisfaction of which leads to a degree, certificate, or diploma. Contact people were asked, "What is the time required to implement a complete change in a program?"

Table 7 shows that the one-month to one-year time frame was the most often mentioned; 33 of 65 for 51 percent. Eight percent (5 of 65) needed less than a month; nine percent (6 of 65) needed more than one year but less than 2 years. Twelve percent (8 of 65) needed two to four years. Twenty (13 of 65) were undetermined.

TABLE 7

TIME REQUIRED TO IMPLEMENT A CHANGE IN A PROGRAM SEQUENCE

Degree Program	Less than 1 month	1 month-1 year	more than 1 year; less than 2	2-4 years	more than 4 years	Undetermined
Associate	1	3	3	0	0	0
Bachelors	1	6	0	2	0	2
Masters	3	12	2	5	0	6
Engineer	0	1	1	1	0	0
Doctoral	0	11	0	0	0	5
TOTAL	5	33	6	8	0	13

It was believed that the compilation of such information could provide useful and informative comparisons by degree level, by geographic location, and by other related variables. It was also thought that this information would provide insights into the flexibility or lack of flexibility in the development and modification of courses and programs. This information holds potential interest to those considering the development of curricula, to those currently offering, but considering the modification of curricula, and to potential funding sources.

E. Environmental Occupations

During the interviews for Phase II, faculty members were questioned regarding occupations that their programs' graduates are qualified for upon completion of the degree. To verify data and maintain consistency, respondents were subsequently mailed occupational checklists specific to their program area(s); they were asked to indicate those occupations listed which their graduates are qualified to fill, and to add any additional occupations not already listed. This section summarizes the results of these components of the Phase II survey.

Ten programs (minor, certification and associate) were visited in air training programs. Contact people feel their students are being trained for the following occupations:

AIR

Air Pollution Analyst
Air Pollution Control Chemist
Air Pollution Control Engineer
Air Pollution Control Inspector
Air Pollution Control Inspector (Trainee)
Air Pollution Control Supervisor
Air Pollution Control Technician
Air Pollution Control Technician (Trainee)
Air Pollution Control Equipment Technician
Air Pollution Monitor
Mechanical Tester

GENERALIST

Biological Technician
Biophysicist
Chemical Spill Control Technician
Environmental Control Technologist
Environmental Engineering Technician
Environmental Health Aide/Technician
Environmental Monitor Specialist
Environmental Science Technician
Environmental Tester/Analyst
Health Monitor
Industrial Hygienist
Pollution Control Specialist
Public Health Sanitarian/Inspector/Engineer
Resource Conservation Technician
Sanitarian

In addition to the above occupations, bachelors programs (7 were visited) felt they train students for:

AIR

- Climatologist
- Meteorologist

GENERALIST

- Chemist
- Ecologist
- Environmentalist
- Environmental Engineer
- Geologist
- Industrial Engineer
- Medical Technologist
- Meteorologist
- Microbiologist
- Physical Science Technician
- Safety Engineer
- Sanitary Engineer

The thirty-five masters and twenty-three doctoral programs visited include the above occupations and added:

AIR

- Academic
- Aerosol Physicist
- Air/Water Control Engineer
- Consultant
- Researcher

GENERALIST

- Oceanographer

The air occupation most often mentioned for those students receiving associate and bachelors degrees were Air Pollution Control Inspector (Trainee). For the masters, it was Air Pollution Control Engineer. On the doctoral level, Air Pollution Control Chemist and Air Pollution Control Engineer were most often cited.

In the generalist category, the occupation most often cited was:

Degree	Occupation
Associate	Environmental Tester/Analyst
Bachelors	Pollution Control Specialist
Masters	Environmental Engineer
Doctoral	Environmental Engineer

It should be noted that there is some disagreement by contact people as to what occupations graduates of the various programs are qualified to fill. Those institutions that confer associate degrees often listed the same occupations as those institutions that trained masters-doctoral students.

F. Image of Environmental Programs

There does not appear to be any across the board image in air programs at the 45 institutions visited nationally. Feelings range from a 'harmless nuisance' to an area that should be covered but is not essential to be a bona fide engineer, to an area that will see tremendous growth because of the need for qualified personnel. Image also depends on publicity - campus newspapers have both helped and hindered various programs.

In some institutions the air training program is considered the most successful and productive engineering program in the school. In others the withdrawl of EPA funds has made it necessary to incorporate the air option into an already existing department and in turn the thrust of the program has changed.

G. Useful Curriculum Materials

Contact people responded in one of two ways concerning the question of useful curriculum materials. Some answered by stating what would be helpful to them and others stated what materials they were presently using that were successful.

First, helpful items that are needed:

- courses need to be more specific; in the past they have been too general and superficial
- there is a need to explain the interactions of various decisions more rationally than has been done in the past
- education of local people is vital to cooperation and success of an idea

Secondly, successful curriculum materials currently being used:

- video tapes to develop students communication skills
- three-quarter inch mini-lesson audio visual tapes for transfer materials produced by EPA
- descriptive audio visual materials (i.e., slide-tape presentations) relating to federal laws and regulations as well as the structure of environmental control mechanisms

H. Student Communication and Financial Management Skills

During Phase I of the National Environmental/Energy Workforce Assessment, researchers noted that a large number of the persons interviewed, who employ environmentally trained/educated personnel, observed that many graduates are being produced who are deficient in the much-needed communication and financial management skills. During Phase II, faculty of the environmental/energy programs were questioned regarding their own attitudes on this subject in order to ascertain the consistencies or discrepancies in perceptions between academia and prospective employers of graduates.

There is a general consensus that these two areas are ones where many students show weaknesses. This is true in all areas, not just environmentally related ones. Institutions choose various means to handle these problems. It should be noted, though, that some contact people feel that it is almost "too late" for remediation work at the college level. The problem needs emphasis at an earlier educational level. Communication skills were seen as the weaker of the two. Examples of how these problems are handled follows:

Oral Communication Skills:

- developed through a summer practicum,
- core project in which presentations and discussions are conducted with classmates,
- several seminars per year where students present reports for peers, faculty, etc.,
- requiring an undergraduate speech course.

Written Communication Skills:

- Composition Task Force requires students in the College of Engineering to pass an examination or take remedial work in technical report writing,
- courses requiring writing many reports,
- trying to simulate technical writing based on field experience, lab work, etc.,
- requiring students to take 12 hours of communication and a developmental communication course (emphasis on technical writing, speech, reading).

Financial Management Skills:

- incorporating these skills into present curriculums,
- basic required courses,
    (a) Introduction to Management Mathematics
    (b) Public Finance and Cost Benefit Analyses
- students learn by experience and through discussion of financial implications in some courses.

I. Methods Utilized by Faculty Members for Keeping Current in the Field

Since a great deal of information is published concerning air programs, it is important that this be disseminated in the most advantageous manner. Textbooks have proven to be inadequate because they are often outdated by the time they are printed. Thus contact people were asked how they kept current in their field. Some answers were:

- organizations,
- professional associations,
- journals,
- consulting,
- research,
- seminars (industry, educational, etc.),
- professional publications,
- short courses,
- conferences,
- updating lectures,
- personal contacts,
- Argonne Laboratory workshops,
- Ohio Academy of Science,
- EPA laboratories in Cincinnati and Research Triangle Park,
- Air and Water Pollution Control Federation,
- interaction with others in specific departments,
- serving on EPA advisory capacity,
- contact with graduates in EPA,
- library,
- publishing,
- papers.

III

A Summary Profile of Representative Educational Programs

The following footnotes (1-6) refer to the various column headings of the Table. Other footnotes are specific to the figures which were provided by various institutions and are used throughout the Table.

[1] Enrollment	1976-77 statistics
[2] Graduates	average for last three years; 'change' indicated apparent trends within that three-year period
[3] Employment	'other' includes positions such as those found within the educational community
[4] Faculty	full-time and part-time is determined by individual institutions
[5] Internship/Applied Study	part of an option to obtain a degree; may or may not have financial reimbursement connected with it
[6] Graduate Follow-up	a standardized procedure that enables the institution to periodically determine the employment of their graduates
NA	Not Applicable/Not Available
*Asterisk	denotes that a program appears in more than one volume of the profile

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1] FULL TIME	ENROLLMENT[1] PART TIME	GRADUATES[2] No. / YEAR	GRADUATES[2] CHANGE
CT	Yale University	*Environmental Health	M.P.H.	20	0	10	Stable
DE	The University of Delaware	*Environmental Engineering	M.A.S. M.E.	14	15	6	Stable
			Ph.D.	1	0	1	Stable
FL	University of Florida	Air Pollution	M.E. M.S.	103		4 22	Down Stable
			Ph.D.	15		6	Stable
			Engr.	0		0	Stable
IL	Prairie State Community College	Air, Water and Wastewater Technology	Cert.	0	0	1	Down
			A.A.S.	5	0	2	Down
IN	Purdue University	*Environmental Science Option	B.S.	15	0	4	Stable
IA	University of Iowa	*Environmental Engineering	M.S.	27	25	14	Stable
			Ph.D.	5	0	1	Stable
KT	University of Kentucky	*Environmental Engineering	M.S. Ph.D.	6		5	Down

(a) estimated; (b) refers to all graduates of Civil Engineering

8

AIR EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
25/50/25		50%	50%		10	0	X			X
30/40/30	30%	40%	30%		4			X		X
40/60/NA[a]	11%	19%	40%	19%	17			X	X	
	23%	24%	29%	24%				X	X	
100/NA/NA	N/A	N/A	N/A	N/A	1	2		X		X
67/33/NA	25%		50%	25%	280	0		X		X
75/20/5	15%	50%	35%		6	5	X		X	
60/40/NA	57%[b]	3%[b]	17%[b]	23%[b]	10		X		X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

				ENROLLMENT[1]		GRADUATES[2]	
STATE	INSTITUTION	PROGRAM	DEGREE	FULL TIME	PART TIME	No. / YEAR	CHANGE
MD	University of Maryland	Environmental Engineering	M.S.	18	18	8	Up
MA	Harvard University School of Public Health	*Environmental Health Sciences	S.M.	45	5	13	Stable
			Sc.D.			2	Stable
	Massachusetts Institute of Technology	*Environmental Engineering	Envir. Eng.	3	0	2	Stable
	Northeastern University	*Environmental Engineering and Science	M.S. (AM)	16		13	Stable
			(PM)		245	30	Stable
	Springfield Technical Community College	*Environmental Technology	A.S.	26	0	10	Up
MI	Michigan Technological University	*Environmental Engineering	B.S.C.E. B.S.E.	135		30	Stable
			M.S.C.E.	18		11	Stable
	University of Michigan	*Industrial Hygiene and Air Pollution	M.P.H. M.S.	28		18	Stable
			D.P.H. Ph.D.	11		2	Stable

8

AIR EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/ APPLIED STUDY[5]		GRADUATE FOLLOW-UP[6]	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
50/35/15	60%		40%		6			X		X
40/60/NA	45%	25%	25%	5%	7	2	X		X	
40/60/NA	45%	25%	25%	5%						
NA/NA/NA		50%	35%	15%	N/A	N/A	X			X
NA/NA/NA NA/NA/NA	15%	50%	35%		9	0	X			X
90/10/NA	20%		80%		2		X		X	
87/13/NA	25%	35%	40%		4	0		X	X	
87/13/NA	25%	35%	40%							
50/50/0	90%		10%		3	0	X		X	
50/50/0	90%		10%							

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES [2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
MO	University of Missouri - Rolla	*Environmental and Sanitary Engineering	M.S.	13	45	N/A	
			Ph.D.	1			
	Washington University	Air (emphasis)	M.S.	0	4	4	Stable
			D.Sc.	1	2	2	Stable
NJ	Middlesex County College	*Environmental Health Science Technology	A.A.S.	15	4	15	Stable
	New Jersey Institute of Technology	Interdisciplinary studies in environmental engineering	M.S.	70	60	40	Up
	Rutgers - State University of New Jersey	Environmental Science	M.S. Ph.D.	70	60	40	Up
	Stevens Institute of Technology	Air Pollution Control Engineering (Mini-Graduate)	Cert.	4	0	N/A	
NY	Hudson Valley Community College	*Public Health Technology - Environmental Health Option	A.A.S.	45	0	20	Down

8

AIR EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/ APPLIED STUDY[5]		GRADUATE FOLLOW-UP[6]	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
NA/NA/NA	50%		50%		7			X		X
NA/NA/NA	N/A	N/A	N/A	N/A	2			X		X
100/NA/NA		83%	17%		4	0	X		X	
96/4/NA	35%		50%	15%	20		X			X
75/25/NA		35%	50%	15%	10	0	X			X
		35%	50%	15%				X		X
50/25/25	N/A	N/A	N/A	N/A	1	0		X		X
90/10/NA		15%	85%		1	1		X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1] FULL TIME	ENROLLMENT[1] PART TIME	GRADUATES[2] No. / YEAR	GRADUATES[2] CHANGE
	Rensselaer Polytechnic Institute	*Environmental Engineering	B.S.	20	0	25	Stable
			M.E.	42	14	20	Stable
			M.S.				
			D.E.			3	Stable
			Ph.D.				
	Syracuse University	*Chemical Engineering	B.S.	95	0	14	Stable
			M.S.	20	0	3	Stable
			Ph.D.				
NC	North Carolina State University	Air Conservation	Minor (M.S., Ph.D.)	10	N/A	5	Stable
	University of North Carolina at Chapel Hill	Air and Industrial Hygiene	M.S.	18	N/A	0	
			M.S.P.H.			7	Stable
			M.S.E.E.			4	
			Ph.D.	13	N/A	1	Stable
ND	North Dakota State School of Science	Environmental Science Technology	A.A.	1	0	2	Down
OH	Muskingum Area Technical College	*Environmental Quality Control Technology	A.A.S.	26	4	8	Up

(a) estimated

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AIR EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
20/80/NA	20%	60%	20%		4.5	5.5	X		X	
60/40/NA	95%		5%		7	0		X		X
15/85/NA	95%		5%							
60/40/NA	10%[a]	10%[a]	80%[a]			39		X		X
34/57/9	25%	4%	50%	21%	6	7		X	X	
	67%		33%							
100/NA/NA			100%		7			X		X
99/1/0	60%	40%			2	0	X		X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
	Ohio State University	Chemical Engineering (air)	B.S.	25	0	25	Up
			M.S.	3		2	Stable
			Ph.D.	1		0.5	Stable
	University of Cincinnati	*Air Pollution Industrial Hygiene	M.S.	4	4	4	Down
			Ph.D.	2	6	0.5[a]	Down
OR	Portland State University	Environmental Engineering	M.S.	8		4	Down
PA	Carnegie-Mellon University Carnegie Institute of Technology	*Environmental Engineering	B.S.	120	0	34	Up
			M.E. M.S.	20	0	19	Up
			Ph.D.	8	0	2	Stable
	Drexel University	*Environmental Engineering and Science	M.S.E.E.	105	69	15	Up
			M.S.E.S.			12	Up
			Ph.D.			4	Stable
	The Pennsylvania State University	Air Pollution Control Technology	A.A.P.C.T.	3	0	3	Down

(a) one every other year; (b) additional schooling

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AIR EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/ APPLIED STUDY[5]		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
90/NA/NA	N/A	N/A	N/A	N/A	1			X	X	
70/10/20	N/A	N/A	N/A	N/A				X	X	
NA/NA/20	N/A	N/A	N/A	N/A				X	X	
20/65/15	60%		40%		10	0		X	X	
								X	X	
90/10/NA	70%		30%		2	0		X	X	
50/50/NA	40%	30%	30%		6	7		X	X	
25/62/18	40%	30%	30%					X	X	
25/62/18	40%	30%	30%					X	X	
50/50/NA	60%		40%			37		X	X	
50/50/NA	60%		40%							
100/0/NA		50%	40%	10%[b]	1	0		X	X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
	The Pennsylvania State University (cont'd)	*Environmental Engineering	B.S.	130	3	23	Up
			M.S. M.E. Ph.D.	19		8	Up
		*Environmental Pollution Control	M.E. M.P.C. M.S.	26	1	14	Stable
	Temple University	*Environmental Technology	A.T.	8	0	2	Down
		*Environmental Engineering Technology	B.S.	64	12	15	Up
	University of Pittsburgh	*Environmental and Sanitary Engineering	B.S.	35	0	12	Up
			M.S.	30	30	35	Up
			Ph.D.	20		4	Stable
SC	Clemson University	Air Pollution	M.Engr. M.S.	2	N/A	1	Stable
	Sumter Area Technical College	*Environmental Engineering Technology	A.E.T.	28	N/A	4	Stable

(a) figures refer to entire department during 1976-1977

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AIR EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR INDUSTRY	PRIVATE SECTOR CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
90/10/NA	25%	45%	30%		10		X			X
50/50/NA	25%	45%	30%		6			X		X
50/50/0	50%		30%	20%	0	40		X	X	
80/20/NA	40%	40%	20%		2	0	X		X	
80/20/NA	40%	40%	20%				X		X	
95/5/NA	30%	50%	20%		8	0		X	X	
60/20/20	30%	50%	20%					X	X	
60/20/20	30%	50%	20%					X	X	
40/60/NA[a]	15%	20%	65%		7[a]	10		X	X	
90/10/0	20%		80%		2	0	X		X	

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1]		GRADUATES[2]	
				FULL TIME	PART TIME	No. / YEAR	CHANGE
TN	University of Tennessee	Environmental Engineering; (Air Quality and Pollution Control)	M.E. M.S.E.E.	32	21	16	Stable
			Ph.D.	4		3	Stable
	Vanderbilt University	Environmental and Water Resources Engineering/ Air Resources	M.Engr.	6	2		Up
			M.S.	16	6		Stable
			Ph.D.	10		2	Stable
TX	University of Texas, Austin	Environmental Health Engineering	M.S.	7	5	3	Stable
			Ph.D.	0	3	1	Stable
VA	George Washington University - NASA	Environmental Modeling	M.S.	0	3	4	Up
WA	University of Washington	Air Resources	M.S.	19		10	Up
			Ph.D.	10		2	Up
	Washington State University	General Air Pollution	M.S.	9	3	5	Stable

(a) industry plus consulting; (b) includes EPA state agencies, other federal agencies

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AIR EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
60/35/5	21%	17%	41%	21%	7			X	X	
10/90/NA	25%[a]		75%[b]		8			X		X
50/50/NA	20%	35%	35%	10%	7	2		X	X	
50/50/NA	20%	35%	35%	10%						
NA/NA/NA	60%		40%		0	15	X			X
40/60/NA	40%		60%		3.5		X			X
40/60/NA	40%		60%				X			X
30/70/NA	60%	20%		20%	12	0	X			X

TABLE

A SUMMARY PROFILE OF REPRESENTATIVE

STATE	INSTITUTION	PROGRAM	DEGREE	ENROLLMENT[1] FULL TIME	ENROLLMENT[1] PART TIME	GRADUATES[2] No. / YEAR	GRADUATES[2] CHANGE
WI	University of Wisconsin - Milwaukee	Atmospheric and Marine Environmental Program	M.E. M.S.	3		2	Stable
WV	West Virginia University	* Environmental Engineering	M.S.C.E M.S.E.	200	0	10	Stable

8

AIR EDUCATIONAL PROGRAMS

STUDENT ORIGIN IN-STATE/ OUT-OF-STATE/ FOREIGN (%)	EMPLOYMENT				FACULTY[4]		INTERNSHIP/[5] APPLIED STUDY		GRADUATE[6] FOLLOW-UP	
	PRIVATE SECTOR									
	INDUSTRY	CONSULTING	GOV'T	OTHER[3]	FULL TIME	PART TIME	YES	NO	YES	NO
70/20/10	57%		43%		3	0		X	X	
50/40/10	15%	10%	75%		5	3		X		X

Photo reprinted from the
Michigan Technological
University Catalog 1975-76

PROJECT COMMENTARY

Photo reprinted from the
University of Missouri,
Columbia Bulletin 1977

PROJECT CONSTRAINTS

In preparation for the on-site interviews, all of the institutions' catalogs were intensively reviewed in order to determine where environmental programs were being offered. During the course of this study, 171 institutions were visited and a total of 338 environmental programs, representing 45 states and Washington, D.C., were surveyed in detail. Albeit significant, these programs represent only a portion of all such programs available and cannot be construed as an in-depth survey of all environmental programs. It is, however, a representative sample within each of the environmental pollution control areas of Air, Noise, Pesticides, Radiation, Water and Wastewater, Solid Waste and Energy.

Several constraining factors to the proposed comprehensiveness of the study were encountered while collecting data from the institutions. It was disappointing to find that definitive records or statistics were generally unavailable which would describe specifically the placement of environmental program graduates. General indications of placement within categories, such as government or industry, were often available in percentages only. Depending on the size of the program and its age, some contact people could describe all graduates, others knew only where the past year's graduates were presently employed, and still others were aware only of their advisees entry-level positions and subsequent moves.

It also became clear during the on-site interviews that some programs of similar or identical content had different titles. This lack of clarity within the environmental areas serves to confuse the casual reader. For that reason, attention must be directed to the actual environmental course listings included in each program summary.

A list of terms commonly used during the on-site interviews and subsequently in this report was developed in order to facilitate precise data gathering. The reader is directed to Appendix II, TERMINOLOGY.

No attempt was made, in this report, to qualitatively judge any of these programs. The apparent absence of substantial qualitative measures in the environmental education field in general and the desire to collect data in a neutral atmosphere underscore the reasons for this omission. It appears that there is a need for the development of an environmental program model in each of these areas in order that some qualitative standards be provided where none now exist.

PROJECT COMMENTARY

The information gathered in Phase II shows that the number of students in air training programs traditionally has been small but has been on the decline for the last few years. This has been attributed to non-funding by the federal government of training programs. Programs were started, equipment purchased and research initiated. Once the seed money was withdrawn for student support and other funds were not readily available, the decline became more evident.

In a September, 1974 APCA Journal article titled "The Crisis in Air Pollution Manpower Development" written by Dade W. Moeller, chairman of the National Air Pollution Manpower Development Advisory Committee, the same conclusion was reached. Three studies were done in a two year period by the National Air Pollution Manpower Development Advisory Committee (NAPMDAC). One of the studies concerned itself with the effects of reductions in training and research grants and contract funds on air pollution programs in colleges and universities. Also studies was the impact of this situation on the availability of well qualified personnel to serve in control agencies. The conclusion reached was that the quality of graduate level programs were being eroded. Phase II shows that the situation has not improved in the intervening three and a half years. The removal of a national emphasis on air and the reduction of federal sponsorship has greatly curtailed the programs and their potential.

Contact people were asked to share their views on the future of environmental programs. Some comments were:

- within Industrial Hygiene, there will be a need for graduates for the next 10-15 years before the saturation point is reached
- a steady and slow growth is projected because of the continuing complexity of the problem
- there is some concern that the legislation places too much emphasis on meeting government standards rather than professional ones
- although the feeling is one of optimisim, growth is seen as being dependent upon congressional funding
- the main concern is the withdrawal of EPA funds and the resulting downward enrollment trends that have followed
- this downward enrollment has meant a lack of qualified people for employment in control agencies
- air programs down for quite a while because there is more concern with energy production

LIST OF AIR TRAINING INSTITUTIONS BY DEGREE

Photo reprinted from the Michigan Technological University Catalog 1975-76

LIST OF AIR TRAINING INSTITUTIONS BY DEGREE

CERTIFICATE

Stevens Institute of Technology (graduate level work)

ASSOCIATES

*Hudson Valley Community College
*Middlesex County College
*Muskingum Area Technical College
North Dakota State School of Science
Prairie State Community College
*Springfield Technical Community College
*Sumter Area Technical College
*The Pennsylvania State University

BACHELORS

*Purdue University

MASTERS

Clemson University
George Washington University - NASA
*Massachusetts Institute of Technology
*New Jersey Institute of Technology
*Northeastern University
Portland State University
*The Pennsylvania State University
University of Maryland
University of Wisconsin - Milwaukee
Washington State University
*West Virginia University
*Yale University

MULTIPLE DEGREES OFFERED BY ONE INSTITUTION

Associate/Bachelors

*Temple University

Bachelors/Masters

*Michigan Technological University

Bachelors/Masters/Ph.D.

*Carnegie-Mellon University - Carnegie Institute of Technology
Ohio State University
*Rensselaer Polytechnic Institute
Syracuse University
*The Pennsylvania State University
*University of Pittsburgh

LIST OF AIR TRAINING INSTITUTIONS BY DEGREE (Cont'd)

MULTIPLE DEGREES OFFERED BY ONE INSTITUTION (Cont'd)

Masters/Ph.D.

- *Drexel University
- *Harvard University School of Public Health
- North Carolina State University (minor)
- Rutgers - State University of New Jersey
- *University of Cincinnati
- *University of Delaware
- University of Florida
- *University of Iowa
- *University of Kentucky
- *University of Michigan
- *University of Missouri - Rolla
- University of North Carolina at Chapel Hill
- University of Tennessee
- University of Texas, Austin
- University of Washington
- Vanderbilt University
- Washington University

NON-INSTITUTIONAL PROGRAMS

- Air Pollution Control Association
- U.S. Environmental Protection Agency

*Denotes that the program appears in an additional volume(s)

AIR TRAINING

SUMMARIES

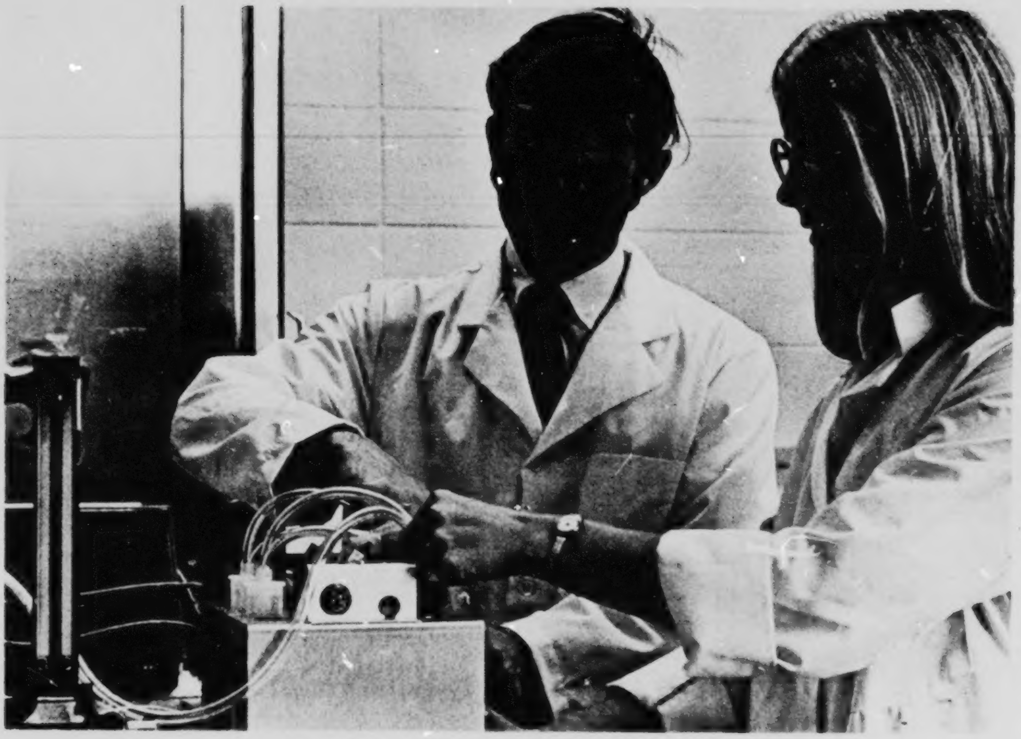

Photo reprinted from the 1976-77 Annual Report, Engineering Experiment Station, College of Engineering, University of Wisconsin, Madison

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INSTITUTION: CARNEGIE-MELLON UNIVERSITY
CARNEGIE INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.), Master of Science (M.S.)
Master of Engineering (M.E.), Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Francis Clay McMichael
Head, Department of Civil Engineering
Carnegie-Mellon University
Carnegie Institute of Technology
5000 Forbes Avenue
Pittsburgh, Pennsylvania 15213
(412) 621-2600

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering is not emphasized as a formal program at the Carnegie Institute of Technology. Emphasis is placed on research on environmental topics which is mainly conducted by departments of the College of Engineering. The principal areas of research are air pollution, industrial wastewater, solid waste management and energy. The prinicpal degree granting departments in the College conducting environmental research are the Chemical, Civil, Mechanical and Engineering and Public Policy Departments. The Engineering and Public Policy Department is also part of the Graduate School of Urban and Public Affairs. All of these departments are involved in undergraduate projects and graduate thesis research in the field of environmental engineering.

Selected institutes or research programs of the Carnegie Institute of Technology which are involved in environmental engineering are the Environmental Studies Institute (to be renamed the Center for Energy and Environmental Studies) which grants an M.E. in Environmental Studies, and the Division of Nuclear Science and Engineering.

The Department of Civil Engineering offers a graduate study option in Environmental Engineering. Emphasis is on water and wastewater treatment and management, and students receive a sound understanding of water science and water process technology. The Department cooperates with other departments and colleges within Carnegie-Mellon University to sponsor interdisciplinary programs leading to special degrees or joint degrees.

Research facilities for use of students in the program include an Environmental Engineering Laboratory for research mainly in the areas of water and wastewater chemistry. A unit operation laboratory is also utilized for both teaching and research. A clean laboratory is presently under construction for aerosol studies. Analytical facilities are available to measure common inorganic and organic indices of water quality.

PROGRAM REQUIREMENTS

The Department of Civil Engineering offers a variety of degrees at the Master's level. They include: M.S. in Civil Engineering; M.S. in Civil Engineering/Engineering and Public Policy; and Master of Engineering. The Master of Science degree requires a minimum of 96 academic units consisting of:

(1) at least 36 units of graduate courses in Civil Engineering;
(2) a minimum of 24 (a maximum of 42) units of graduate project,
(3) other approved courses as suggested by the faculty advisor, and;
(4) satisfactory completion of either a comprehensive final examination or an M.S. thesis.

The Department's Master of Engineering degree normally requires a minimum of 192 units of work with strong emphasis on interdisciplinary project work. Students register in an enigneering department but select problems drawn from areas such as the environment. Ph.D. cnadidates complete an additional two years of graduate study beyond the M.S. degree. A qualifying examination and final examination are required, but no foreign language is required. There is a one-year residence requirement for the Ph.D.

Research assistantships, teaching assistantships and fellowships are offered to graduate students as financial aid. A much greater number of assistantships is available in comparison with the number of fellowships. Graduate assistantships are usually one-third time appointments requiring 12 hours of work for the Department weekly.

CURRENT FACULTY, STUDENTS, GRADUATES

The College of Engineering faculty, totaling about 90, teach both undergraduate and graduate students. The faculty devote about 67 percent of their time to teaching and 33 percent to research activities. The Civil Engineering faculty is composed of thirteen members, of whom six are full professors. Three professors have research interests in environmental engineering areas.

During 1977, the College of Engineering had research expenditures totalling about $6 million, of that amount, $3 million was for energy research, and one-third of the energy expenditures ($1 million) was for environmental-energy research. The main funding source is the National Science Foundation, and ten percent is provided by industry.

The College of Engineering has a total undergraduate enrollment of 1,200 students, most of which are full-time. Approximately 90 percent are male. There are about 400 graduate students (5% female) and approximately 40 are part-time. It is estimated that 350 students annually complete the baccalaureate requirements and 100 students earn advanced engineering degrees. In Civil Engineering, twenty students were enrolled in the Master's programs in the fall of 1976, and eight students were enrolled in the Ph.D. program. During the 1975-76 school year, 34 students earned undergraduate degrees, 19 earned Master's degrees and two students received the Ph.D.

Approximately twenty percent of the students receiving B.S. degrees continue directly to graduate schools. It is expected that all graduates obtain employment directly in their field and 70 percent obtain positions in the private sector. Although the university maintains a Placement Office, students are also very successful in obtaining employment through individual contacts.

PROGRAM PROJECTIONS

Emphasis in the environmental engineering program in future years will remain on industry and the attempt to solve environmental and energy, fuel substitution, solar energy, and increased coal use problems. The Civil Engineering Department has no intention of developing a separate undergraduate major in environmental engineering. No change is foreseen in the institutional arrangements for degrees, but an increased emphasis on energy/environmental problems is expected. One additional faculty member was recently added to the environmental engineering program in the Civil Engineering Department. He has a doctorate, and his research interests include air pollution, and specifically, in trace metals in aerosols.

COURSE DESCRIPTION

12-721 Dynamic Hydrology - A theoretical basis is provided for analyzing water movement within the hydrology cycle; survey of important principles used in the analysis of ground water flow with applications to basin-wide ground water management; the design of industrial and domestic land and deep well waste disposal systems and to the prevention of water problems in coal mining operations; and other topics. (9 s.h.)

12-722 Wastewater Treatment: Theory and Design - Theory and design of wastewater treatment unit operations including sedimentation, activated sludge, and biological filtration. Material covered includes biological process kinetics, and theory and practice of advanced wastewater treatment processes. The design of solid handling systems focuses on thickening, digestion, incineration, and terminal disposal facilities. Laboratory sessions illustrate chemical principles of dilute aqueous systems and provide familiarity with chemical measurements commonly used in water and wastewater engineering. (9 s.h.)

12-723 Water Resources Chemistry - A rigorous yet practical basis for applying the principles of chemical equilibrium and kinetic models and physical chemistry to a description of the composition of waters and to water and wastewater treatment processes. Laboratory sessions illustrate chemical principles of dilute aqueous systems and provide familiarity with chemicals measurements commonly used in water and wastewater engineering. (9 s.h.)

12-732 Special Topics in Environmental Engineering - Development and application of models for assessing environmental problems with an emphasis on air pollution. Both elementary and more advanced models will be discussed. Consideration will be given to causes and effects of air pollution, control technologies, energy consumption rates and costs, and the need for efficient data collection and management. The course also includes studies of modeling atmospheric transport of air pollutants from source to sink. Offered from time to time as demand warrants. (9 s.h.)

INSTITUTION: CLEMSON UNIVERSITY

PROGRAM: Air Pollution

DEPARTMENT: Environmental Systems Engineering (ESE)

DEGREE: Master of Science (M.S.)
Master of Engineering (M.Engr.)

CONTACT: Dr. Thomas M. Keinath, Professor and Head
Environmental Systems Engineering
Clemson University
Clemson, South Carolina 29631
(803) 656-3276

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Systems Engineering (ESE) at Clemson University grew out of a group of faculty members formerly housed within the Department of Civil Engineering. The mission of this group was to provide graduate level education of environmental engineering professionals, in response to specific needs of the State of South Carolina. After four years, in 1966, a graduate program in Environmental Systems Engineering was formally established as a separate entity within the College of Engineering. In 1968, a formal ESE Department was established.

Originally, there were four areas of specialization within ESE: Water and Wastewater Treatment Systems, Natural Systems, Environmental Science, and Planning and Management. The Air Pollution specialization was added in 1976; prior to this time, only a minor was offered in air pollution. In 1977, the Environmental Sciences specialization was merged with Natural Systems.

At the master's level, the M.S. or the M.Engr. may be pursued. The M.Engr. degree program is accredited by the Engineers' Council for Professional Development at the advanced level. Students must select one of the four current areas of emphasis as a major. A program of study for the Ph.D. is also offered, which provides more flexibility for specialization. Within these degree programs, emphasis is placed on applying the basic principles of the sciences and engineering to the design, operation, planning and management of man-made environmental control systems. These include water and wastewater treatment facilities, air pollution control devices, and the analysis and management of natural systems such as streams, estuaries, and impoundments, as well as the air environment.

The Air Pollution specialization focuses on monitoring, meteorology, and control methods for meeting the national and state air quality standards. The program is designed to train environmental engineers capable of predicting the levels of pollutants from given sources, designing air pollution control equipment, and assisting in the planning of future industrial and residential growth and their related transportation systems. Students in this area take a core of courses in air pollution covering monitoring, meteorology, and control processes. Further specialization may take place through the selection of electives.

Since the formal organization of the ESE Department, it has attracted over two million dollars in external funding, including over one-half million dollars in training grant monies from federal and state agencies. Research funds to date have chiefly gone towards the field of water treatment and water pollution control, as air pollution is the most recent area of emphasis. Active research in air pollution control is being carried out, however, and is rapidly expanding. Current projects include the topics of salt deposition from cooling towers, modeling of plumes from multiple stacks, and particulate sulfate levels in rural areas. Students may become involved with research activities through special projects or as paid research assistants. Master's level students normally participate in applied research. The department houses twelve research laboratories, a precision analytical instrument room, an operations and process laboratory, and a hybrid computer.

In addition to the direct education of graduate level students and the conduct of research, the ESE faculty is of service to the state and region through several other means. Short-term training or retraining has been provided to citizens, governmental agencies, industries and consultants since the mid-1960s in the form of workshops, conferences, seminars and short schools. These have included training in the field of air pollution control. Additionally, the faculty participates in a wide variety of professional activities such as serving on relevant state and federal boards and commissions, assisting in the development of technical curricula and curriculum materials, presenting testimony before Congressional committees, participating in educational television and radio programs, authoring papers, and chairing national and international symposia. One faculty member has served as an expert advisor to the Environmental Protection Agency (EPA), and all faculty members are actively involved with professional environmental associations.

PROGRAM REQUIREMENTS

Admission to the ESE programs requires a bachelor's degree in engineering or a scientific discipline such as chemistry or biology. Non-engineers must have had prerequisite course work in mathematics through differential equations, one year each of physics and chemistry, and courses in computer programming, fluid mechanics, and general environmental engineering. Applicants for the M.Engr. degree must have a B.S. degree in engineering from an ECPD-accredited institution with at least a 3.0 cumulative grade point average on the last sixty hours to be eligible for acceptance. Engineers who have had at least two years of documentable professional engineering experience may be granted full admission provided they have had an undergraduate grade point average of 2.5 or higher. All M.S. program applicants must have earned at least a 3.0 cumulative grade point average on the last sixty semester hours, and must have taken the Graduate Record Examinations with a score of at least 1000 for full admission. An engineering degree is not required to enter the M.S. program; applicants may be eligible with B.S. degrees in such fields as biology, physics, chemistry, or mathematics as long as prerequisite course requirements are met.

Thirty semester hours are required for the master's degrees. One calendar year is normally required for completion of the degrees, although working as teaching or research assistants can prolong the length of study. Each student selects a major advisor. An advisory committee, chosen by the department head, the major advisor and the student, approves the student's graduate degree curriculum, supervises the graduate program, administers the final comprehensive examination, and initiates the recommendation for the awarding of the degree. The Graduate School requires that all M.S. programs include six semester hours of research if the thesis option is taken. Most students elect a two- to three-hour special problem in lieu of the thesis. Of the remaining required hours, at least half must be selected from courses numbered 800 and above. For the M.Engr., at least half of the required hours must be selected from courses numbered 700 and above. A special project is required for the M.Engr. degree.

ESE students pursuing the Air Pollution concentration take a core of six courses, or seventeen semester hours, and select electives based upon specific career objectives. A minor, if selected, consists of at least six hours of credit in the chosen area.

The College of Engineering offers cooperative graduate programs with industry in which semesters of on-campus study are alternated with work assignments in industry. ESE students rarely participate in these programs, as they lengthen the term of study.

CURRENT FACULTY, STUDENTS, GRADUATES

The ESE Department consists of seven faculty members, all holding the Ph.D. degree, with teaching and research interests and responsibilities in diverse environmental fields. As faculty members' activities overlap into two or more of the areas of specialization, identifying the number of faculty for each area is not possible.

There are currently two ESE master's students in the Air Pollution concentration, and there have been three graduates to date. In general, ESE graduates with the M.S. degree are more likely to become employed by governmental agencies, while those with the M.Engr. most ofter enter the private sector. Graduate follow-up data from 1974 through 1977 for the entire department indicate that of sixty-four graduates surveyed, eight became employed by industries, twelve by consulting firms, thirty-nine by governmental agencies (local, state and federal) and five continued their schooling for the Ph.D.

Approximately 95 percent of the ESE students receive financial assistance from a variety of sources, including research assistantships, teaching assistantships, and training grants. The department has an EPA grant which supports two students in air pollution.

PROGRAM PROJECTIONS

Although the department is close to reaching the maximum number of students it can carry with the space available, within three years it is expected that the overall enrollment may increase from the present average of forty to forty-five, to approximately sixty. A portion of this growth may be in the Air Pollution program.

COURSE DESCRIPTION

Core courses:

ESE 802 Principles of Water Treatment Systems - An intensive study of the fundamental principles that are of import to water and wastewater treatment systems. Topics include the principles of biological and chemical reactions, mass and heat transfer, reactor kinetics, absorption and ion exchange, clarification and thickening, transient response analysis and control theory, and methods of operations research. (4 s.h.)

ESE 831 Air Quality Monitoring - Principles of ambient and source measurements of air pollutants. Siting of air pollution monitors. Laboratory exercises in source testing and ambient air analysis. (3 s.h.)

ESE 832 Air Pollution Meteorology - Applications of meteorology to air pollution. Includes micrometeorology, plume rise modeling, atmospheric diffusion, deposition and washout of pollutants, air chemistry and applications of diffusion modeling to air quality planning. (3 s.h.)

ESE 861 Environmental Systems Engineering Seminar - Current advances and research developments in various areas of environmental engineering. (1 s.h.)

ESE 630 Air Resources Engineering - Important aspects of control and utilization of the air environment. Air pollution sources and effects, monitoring procedures, dispersion models, engineering controls, and economics of control. Existing legislation and enforcement principles. (3 s.h.)

ESE 833 Air Pollution Control Processes - Operational and design variables in equipment for removal of gas, liquid and solid phase pollutants from air; basic theory of small particle dynamics; performance and design. (3 s.h.)

Selected approved electives:

EX ST 801 Statistical Methods - Role and application of statistics in research; estimation, test of significance, analysis of variance, multiple comparison techniques, basic designs, mean square expectations, variance components analysis, simple and multiple linear regression and correlation, and non-parametric procedures. (4 s.h.)

CE 612 Urban Transportation Planning - Urban travel characteristics; characteristics of transportation systems; transportation and land-use studies; trip distribution and trip assignment models; city patterns and subdivision layout. (3 s.h.)

CHE 601 Transport Phenomena - Heat, mass, and momentum transport with emphasis being laid on how the three processes are related. A firmer foundation is laid for the previous work in unit operations. (3 s.h.)

CHE 660 Introduction to Occupational Safety and Health - An introduction to the practice and principles of maintaining a safe work environment. Safety engineering and in-plant control of physical and chemical hazards. Occupational safety and health legislation. (3 s.h.)

CH 691 Introduction to Radiochemistry - Natural and synthetic isotopes, including atomic and nuclear structures, properties of radiation, tracer techniques and applications. Laboratory includes methods of detection and measurement of radiation, and application of tracer techniques. (3 s.h.)

CRP 612 City and Regional Planning Theory - Philosophical, methodological, and ethical aspects of planning are explored through selected readings, student reports, lectures and discussions. A critical examination of current planning theories. (3 s.h.)

CRP 672 Implementation of the Local Planning Process - The organization and administration of types of planning agencies and their relationship to other governmental and private organizations. The function and relationship of the various implementing tools available to local government. (3 s.h.)

FM 801 Foundation of Fluid Mechanics - Derivations of basic equations for multi-dimensional flow fields; analytical techniques for solving laminar inviscid flows; theories of similitude. (3 s.h.)

FM 814 Turbulent Boundary Layer - Semi-empirical theories on Reynolds stress terms; analytical methods of solving turbulent boundary layer momentum and energy equations for flows with pressure gradient and heat transfer. Theories pertinent to experimental techniques used for turbulent boundary layer study. (3 s.h.)

INSTITUTION: DREXEL UNIVERSITY

PROGRAM: Environmental Engineering and Science

DEPARTMENT: Multidisciplinary Institute for Environmental Studies

DEGREE: Master of Science in Environmental Engineering (M.S.E.E.)
Master of Science in Environmental Science (M.S.E.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. P. W. Purdom
Director of Environmental Engineering and Science Program
Institute for Environmental Studies
Drexel University
Philadelphia, Pennsylvania 19104
(215) 895-2265

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Initiated in 1963, the graduate program in Environmental Engineering and Science is offered by the Institute for Environmental Studies. The departments of physical sciences, engineering, and life and social sciences cooperate in this multidisciplinary program. The following areas of concentration are offered: Environmental Health; Environmental Planning and Management, Air Resources, Occupational Health; Water Quality and Resources; Solid Wastes; Environmental Assessment; and Environmental Chemistry. Other tracts of study may be developed where the preceding do not meet the student's needs.

Faculty and students utilize research facilities in various colleges for their work in environmental programs. The program's own laboratories include solid wastes, water and wastewater treatment, toxicology, environmental chemistry, and environmental rooms for the study of human behavior and reaction. Small incinerator studies using air flow equipment contained in a large incinerator room are conducted. An environmental library is located at Drexel's library and students have access to computer based abstract services (plotting facilities) and computer terminals. Much research is conducted in collaboration with government agencies and industries in the field. An example is a re-oxygenation study currently being conducted at a dam site in Georgia by a Drexel professor.

PROGRAM REQUIREMENTS

In order to enter this program a strong background in science and mathematics is necessary and applicants are requested to have at least two terms of college chemistry and differential and integral calculus. Students with this background are welcomed from all engineering fields, physical, life, and the social sciences.

The Master of Science in Environmental Engineering is awarded to students holding a Bachelor of Science degree from a curriculum accredited by the Engineer's Council for Professional Development. The Master of Science in Environmental Science is awarded to students possessing a Bachelor of Science degree. All Master's degree applicants complete 48 quarter-credits of course work and full-time students generally require 12 months to complete the program. All students also must complete a project of thesis of six to nine credits. Ph.D. students have a prepared individual course plan which is reviewed by a faculty committee which also administers a candidacy examination. After passing the candidacy examination, the student's research is supervised by a special faculty committee of at least five persons.

Most of the financial assistance provided to graduate students in the program consists of direct grants and fellowships. Drexel awards 15 traineeships supported by the U.S. Department of Health, Education and Welfare. The university supports one teaching assistantship and four to six students with research positions. One laboratory technician is hired by the program. The City of Philadelphia supports three students on a part-time basis.

Many part-time students receive tuition compensation from their employers in industry or government to attend night classes. Most industries in the area do not provide time off during the day to enable their employees to attend day classes so classes are rotated in the evenings.

CURRENT FACULTY, STUDENTS, GRADUATES

Thirty-seven faculty members participate in the teaching of the program's curriculum. Only ten to twenty percent of the staff do not participate in research activities and all faculty are required to teach. Faculty are involved in a broad range of basic and applied research in the following areas: Air Pollution and Air Resources; Water Quality and Water Resources; Solid Wastes; Ecology; Toxicology and Environmental Chemistry; and Environmental Management.

A total of 105 students are enrolled in the program during the fall quarter of 1977 and 69 are part-time(including Master's and Ph.D.). Fourteen students are conducting post-master's work and five passed their candidacy exams to begin work on their doctorates. Two female students are working on post-masters research; four to six are in the M.S. program and one is enrolled in the doctorate program.

During 1976, fifteen students earned the M.S. degree, twelve earned the M.S. in Environmental Science, and four received doctorates. Approximately ten percent of the program's graduates continue on for further education and less than ten percent of those continuing stay at Drexel University. One to two annually attend medical schools, a few go to Schools of Public Health (Michigan, Harvard, North Carolina, Florida) and others go on to various universities, such as, Stanford and the University of Illinois for advanced degrees. Virtually all graduates obtain employment directly in their field and it is estimated that 60 percent obtain private sector jobs and 40 percent find government positions. Most Ph.D.s obtain positions conducting research for industry or private research firms and few with doctorates work for government agencies.

PROGRAM PROJECTIONS

Enrollment has remained stable, although a slight decline has been detected by program officials. Most part-time students are enrolled in water pollution courses. Solid waste courses are now offered every other year. These courses have not been developed as a full-time program. The air pollution specialty may have to be dropped as a specialty area if the number of students enrolled in this area does not increase.

Most faculty additions are expected to result mainly from replacing staff members who have left. Recently, a civil engineer was recruited with an air pollution control engineering background. Two other replacements are foreseen and one, a civil engineer, has a water quality engineering background and the other, a toxicologist, will be recruited by the Biological Sciences Department to teach Biochemistry courses.

Expansion of the program depends on the needs of cities and industry for short course in-service training. If expansion does become necessary it will probably be in the areas of toxic and hazardous substances which are big health problems. Thirty or more students are enrolled in the occupational health specialty area without training grants as they perceive this as an area requiring future trained specialists.

COURSE DESCRIPTION (SELECTED)

F 202 Environmental Chemistry - Principles of physical and organic chemistry applicable to the study and evaluation of environmental conditions, especially the pollution of air, water, and soil. (3 q.h.)

F 208 Fate of Pollutants in the Air and Water Environment - The physical and chemical mechanisms that define the fate of a pollutant are theoretically delineated and applied to model environmental systems. (3 q.h.)

F 209 Advanced Environmental Chemistry - Thermodynamic and kinetic principles and their application to the study of chemical changes and reactions in the water or air environments. (3 q.h.)

F 214 Environmental Physiology - Effects of air pollutants, water pollutants and general environmental factors such as heat, light, sound, stress and activity upon the functions of the human respiratory, nervous, blood and excretory systems. (3 q.h.)

F 221 Environmental Health - Evaluation of environmental hazards, design of environmental controls for the health and well-being of man. (3 q.h.)

F 222 Epidemiology - Principles, purposes and methods of epidemiology; application of methods for the investigation of problems in the field of human diseases, infectious and non-infectious, emphasizing the relationship and equilibrium of host and environmental factors. (3 q.h.)

F 239 Toxicology - Acute and chronic effects of toxic substances and residues. Environmental exposures and controls. (3 q.h.)

F 241 Air Pollution Control Processes - Detailed study of the design and operation of air pollution control processes: settling filtration, inertial separation, scrubbing and precipitation. (3 q.h.)

F 243 Air Pollution Sources - Sources of air pollution will be considered in depth. (3 q.h.)

F 244 Air Resource Management - Component parts of air pollution control programs: air pollution standards, background survey, elements of air pollution control laws, misdemeanor and injunctive surveys, socio-economic surveys, and operation of an air resource management program. (3 q.h.)

F 252 Water Quality Control Laboratory - Analytical procedures used in the assessment of water quality as applied to the analysis of natural waters and to the control of water and waste water treatment processes. (3 q.h.)

F 255 Stream Analysis and Pollution Control - Fundamentals of limnology. (3 q.h.)

F 270 Solid Wastes Systems - An analysis of the public health, economic and political aspects in the operation and design of storage, collection and disposal of solid waste materials. (3 q.h.)

F 279 Environmental Project Analysis - Candidates for the master's degree in Environmental Science, or Environmental Engineering, are required to select an appropriate problem, formulate an approach to its solution, and then test this solution in so far as it is practical. (3 q.h.)

F 291 Research Methods - Introduction to research methods and literature, procedures for the collection and analysis of data; preparation of technical papers. (3 q.h.)

F 298 Thesis - Each student working on a dissertation will file a written report each quarter with his supervisory committee. A copy of this report must be filed with the Program Graduate Student Advisor. (2-12 q.h./term)

INSTITUTION: GEORGE WASHINGTON UNIVERSITY - NASA

PROGRAM: Environmental Modeling

DEPARTMENT: Joint Institute for Advancement of Flight Sciences

DEGREE: Master of Science (M.S.)

CONTACT: John E. Duberg
Director, Joint Institute for Advnacement of Flight Sciences
Mail Stop 169
NASA - Langley Research Center
Hampton, Virginia 23665
(804) 827-2664

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental modeling is offered as a Master's degree level program, normally requiring two-years of study and research. Approximately half of the student's time is devoted to research during the academic year, with a full time research program during the summer. The academic program is designed to prepare students for careers in advanced research, development, design, and teaching.

This program was initiated in 1974 by the Joint Institute for Advancement of Flight Sciences as a cooperative effort between George Washington University's School of Engineering and Applied Science and NASA's Langley Research Center. It is administered as an off-campus program by the College of General Studies of George Washington University and taught at the Langley Research Center.

Research funding for the porgram is provided by NASA. The program also draws upon the research facilities of the Langley Research Center, primarily the computational facilities which include several computer systems.

PROGRAM REQUIREMENTS

The primary requirement for admission to the program is a Bachelor's degree from a recognized institution, preferably in engineering or physics. Additionally, it is possible for non-degree students to take courses in the program with the approval of the department.

A minimum of twenty-four semester hours of approved courses along with a thesis equivalent to six semester hours is required for the Master's degree. With the approval of the department, a student can choose an optional program which requires a minimum of thirty-three hours of credit and no thesis.

Courses in the program are a combination of applied science, engineering science, and mechanical engineering. The primary environmental discipline offered in the program is air pollution control.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently fifteen faculty members involved in the environmental modeling program, most are part-time and have research as their primary function. Of the fifteen,four teach atmospheric sciences and the remainder teach fundamental subjects which apply to several programs. The faculty consists of both members of George Washington University's School of Engineering and Applied Science and research scientists and engineers at NASA's Research Center.

Presently, five part-time students are enrolled in the program. Generally, most of the students in this program are NASA employees and the only formal recruitment is through NASA training announcements and at some local colleges. Students usually receive financial assistance for this program in the form of the NASA work-study program for employees or through research scholar assistantships available from George Washington University.

The number of graduates fluctuates because of the small number of students but in 1977 there were four graduates, which is higher than normal. Graduates have no difficulty in obtaining positions.

PROGRAM PROJECTIONS

Program officials hope to expand the program to meet what they see as a growing need for persons trained in environmental modeling. There is no current timetable for expansion and it is doubtful that any additional faculty would be hired since the NASA Research Center already employs several hundred researchers which can be drawn upon for teaching.

COURSE DESCRIPTION

(the following is a partial listing of courses)

263 Atmospheric Physics for Engineers I - Atmospheric radiation: phenomenological equation of transfer; solutions to the transfer equation; optical, physical, and chemical properties of

263 (Cont.) - atmospheric constituents; remote sensing and the direct inversion problem. (3 s.h.)

264 Atmospheric Physics for Engineers II - Atmospheric dynamics: mean structure of the atmosphere, temperature, pressure, and wind fields; mass, momentum, and energy transfer; large-scale features of atmospheric circulation; regional features of atmospheric circulation. (3 s.h.)

265 Air-pollution Meteorology - Weather and motion systems of atmosphere; ground and upper-level air conditions; atmospheric stability and inversions; effects of meteorological parameters upon transportation and diffusion of pollutants; and other topics. (3 s.h.)

282 Energy Technology - Energy supply and demand; consumption patterns. Interrelationship between energy, environmental, and economic conditions. Dynamic energy conversion systems, direct energy conversion systems, renewable and nonrenewable energy sources, synthesis of fuels, unconventional energy devices and sources, performance analysis. (3 s.h.)

INSTITUTION: HARVARD UNIVERSITY SCHOOL OF PUBLIC HEALTH

PROGRAM: Environmental Health Sciences

DEPARTMENT: Environmental Health Sciences

DEGREE: Master of Science (S.M.)
Doctor of Science (Sc.D.)

CONTACT: Dr. Dade W. Moeller
Head, Department of Environmental Health Sciences
Harvard University School of Public Health
665 Huntington Avenue
Boston, Massachusetts 02115
(617) 732-1169

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Health Sciences program offers a multidisciplinary approach to the study of the effects of environmental pollutants. This program has developed from an industrial hygiene curriculum which began in 1918 and a radiological health program followed in 1946.

Five specialized programs are offered: Air Pollution Control, Environmental Health Management, Industrial Hygiene, Medical Radiological Physics, and Radiological Health. Students take basic courses, common to all five areas, and then normally concentrate in one area. Program requirements are flexible and it is possible for a student to plan a program in two or more of the specializations.

A principal support facility for the program is the Kresge Center for Environmental Health which includes an air cleaning laboratory. Computer facilities are also available through the Harvard Computer Center.

PROGRAM REQUIREMENTS

Program admission for the School of Public Health requires acceptable work in an undergraduate program and three letters of recommendation. Requirements for the environmental health sciences program stipulate that the undergraduate degree should be in math, chemistry, physics, biology, or engineering with a strong background in three of the first four subjects.

S.M. programs may be completed in one or two years. For a one year program, a student must have a master's degree in one of the appropriate sciences or approved prior education and work experience in a related area. A minimum of forty credit units are required for the one year program and at least eighty credit units are required for completion in two years. In addition, the two-year program requires that at least ten credits in the second year be devoted to an appropriate research or related study, followed by a written report. Although students may register for courses at other Harvard graduate schools and at M.I.T., at least fifty percent of the program must consist of courses offered within the School of Public Health.

The Doctor of Science degree requires a minimum of two years in residence while enrolled in the program, and normally takes two to four years to complete. Qualifying examinations at both the department and school level, as well as a thesis representing original research,are also required.

CURRENT FACULTY, STUDENTS, GRADUATES

Program faculty consists of nine members, seven full-time and two part-time. About seventy percent of faculty time is devoted to research and the remainder to teaching. Funding for research is currently provided by EPA, the Department of Energy, and the Nuclear Regulatory Commission.

The program has a current enrollment of 43 full-time and 11 part-time. Several students have used the program as a means for making a career change, particularly from chemistry. Approximately forty percent of the students are in-state residents. Formal recruitment is achieved through advertising in professional journals. Many students enroll, however, after taking short courses offered by the department or through the referral by program alumni. Most students have some form of financial assistance, primarily training grants and fellowships. Several students are also employed part-time.

An average of thirteen students graduate from the S.M. program each year and the Sc.D. program averages two graduates per year. A majority of graduates find employment in private industry or with consulting firms. Others are employed by government agencies or academic institutions. Approximately twenty percent continue their education. Graduates normally find jobs through individual counselling by faculty members, and posted notices of job opportunities.

PROGRAM PROJECTIONS

Officials expect enrollment to increase to an annual average of sixty students within another year. No increase in faculty would be necessary.

ADDITIONAL INFORMATION

Program officials conduct twelve annual short courses in environmental health through the continuing education program. A total of about four hundred students attend these courses each year. A biennial International Air Cleaning Conference is also conducted by program personnel.

COURSE DESCRIPTION

(the following is a partial listing of courses)

Environmental Health Interdepartmental 201a, 201b Principles of Environmental Health - This course reviews the more importnat environmental health problems facing society. Topics in areas "a" and "b" cover different areas, and may be taken separately. (2.5 s.h.)

Environmental Health Interdepartmental 202d Community Environmental Health Management - A Computer-Simulated Gaming Experience - This is a computerized game which simulates a metropolitan environment by including basic data on such factors as air pollution characteristics, employment, land use, and public services. (2.5 s.h.)

Environmental Health Sciences 202b Departmental Seminar - The purpose of these seminars is to supplement the formal course work of the Department by bringing to the attention of students a wide range of topics of contemporary interest in air pollution control, industrial hygiene, radiological health, and environmental health management. (1 s.h.)

Environmental Health Sciences 252a, 252b Environmental Control - The first half of this course centers on the design and evaluation of industrial ventilation systems for the control of toxic contaminants released into the workplace through industrial operations and porcesses. The second half is designed for environmental health specialists responsible for evaluation and control of noise hazards. (2.5 s.h.)

Environmental Health Sciences 261a, b Community Air Pollution - This course is designed for engineers, chemists, and physicians interesetd in air pollution control. (5 s.h.)

Environmental Health Sciences 271a, b Introduction to Radiation Protection - This course covers laboratory, industrial, and environmental sources of radiation; the interaction of ionizing particles with matter; and other topics of current interest. (5 s.h.)

Environmental Health Sciences 272d Special Topics in Radiation Protection - This course covers the physical principles and mathematical analyses utilized in the evaluation and control of radiation hazards. (2.5 s.h.)

INSTITUTION: HUDSON VALLEY COMMUNITY COLLEGE

PROGRAM: Public Health Technology - Environmental Health Option

DEPARTMENT: Engineering Technologies and Industrial Technologies Division

DEGREE: Associate in Applied Science (A.A.S.)

CONTACT: Dr. Charles Zipprich, Chairperson
Environmental Technology Program
Hudson Valley Community College
Vandenburgh Avenue
Troy, New York 12180
(518) 283-1100

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Hudson Valley Community College is sponsored by the County of Rensselaer under the program of the State University of New York. It is a member of the Middle States Association of Colleges and Secondary Schools. Seven of the College's engineering curricula are accredited by the Engineers Council for Professional Development.

The Public Health Technology - Environmental Health Option is a two-year program designed to educate technicians with a sound foundation in science, mathematics, and environmental engineering. Technicians often perform such tasks as laboratory analysis, sampling, inspections, and operation of treatment plants. With consulting sanitary engineering firms a technician may assist in the design, construction and start-up of water pollution control plants or become involved in comprehensive wastewater studies. Employment opportunities are available as environmental health technicians and sanitarians in city, county and state health departments. Graduates also find employment as chief superintendents and shift operators at municipal and industrial water and wastewater treatment plants. Within industry, positions are available performing laboratory analyses and stack testing.

The College furnishes a laboratory with stack sampling and other similar types of equipment students receive training through courses in water purification, wastewater treatment, air pollution control, limnology, environmental quality, and participate in a two semester environmental seminar.

PROGRAM REQUIREMENTS

In order to enter the program, two years of high school mathematics is required and it is helpful to have taken additional science and mathematics courses. Structured into two year, four semester curriculum are 64 credit hours which include eleven courses not specifically environmental health such as physics, biology, ecology, and microbiology.

The College has developed thirty slide and tape programs on limnology. One of the faculty members works at the Rensselaer County Waste Treatment Plant and thus is able to maintain current with industry needs. The College also conducts continuing education courses for Grade Two water and sewage treatment plant operators.

New York State residents can apply for Tuition Assistnace Program Grants which are based on need and range from $100 to $600 per year. Other grants and loans available include the Basic Education Opportunity Grant, the New York Higher Education Assistance Corporation Loans, Educational Opportunity Grants and so on.

CURRENT FACULTY, STUDENTS, GRADUATES

Two faculty members (one full-time) teach the Environmental Health courses. The Program has a total enrollment of 45 full-time students (fall, 1977) including ten females. Only one additional student attends on a part-time basis. About twenty students annually graduate and receive the A.A.S. degree although it is expected that the number graduating will begin to drop.

Many students decide to continue their education for higher degrees and the College has a transfer agreement with the State University of New York at Plattsburgh to accept Hudson Valley College's students into its B.S. Environmental Studies Program. Others have continued to the Rensselaer Polytechnic Institute, the University of Buffalo, Syracuse University, the University of Alaska and SUNY at Albany's Environmental Science Program. Approximtely one-third of the graduates continue on for higher degrees and it is estimated that fifty to sixty percent of the graudates of the program find employment in their field and about 85% find government jobs. The College has a Placement Office to assist students in their search and referrals are accepted by the program from employers.

COURSE DESCRIPTION

1802 Environmental Quality - Coverage of public health activities with particular reference to environmental sanitation, solid waste disposal, radiological health, and others. Laboratory will emphasize use of radiation monitoring techniques, noise measurements, and field trips to pertinent facilities. (4 s.h.)

1806 Environmental Seminar - This course is designed to give the student an overview of the environmental dilemma facing society. (1 s.h.)

1811 Water Purification - Design and operation of water purification and distribution systems for domestic and industrial installations. (4 s.h.)

1813 Waste Water Treatment - Design and operation of waste water collection, treatment and disposal systems for domestic and industrial installations. (4 s.h.)

1820 Air Pollution Control - An introduction to air pollution control including effects and sources of air pollution, transport and sampling of air pollutants, control equipment. The laboratory consists of sampling and anaylsis of air pollutants. (4 s.h.)

1830 Limnology - A consideration of the physical, chemical and biological characteristics of unpolluted and polluted lakes and streams. The laboratory will consist of extensive sampling and analysis of a lake or stream chosen by the instructor for study. (4 s.h.)

INSTITUTION: MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PROGRAM: Environmental Engineering
DEPARTMENT: Interdepartmental
DEGREE:
Environmental Engineer (Env.E.)

CONTACT: Dr. Peter S. Eagleson
Chairman, Interdepartmental Environmental
Engineer Degree Committee
School of Engineering
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139
(617) 253-2725

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering at MIT is an interdisciplinary program administered by the School of Engineering and composed of faculty from the various engineering departments and from other relevant departments throughout the Institute. The program was initiated in 1973 and provides preparation in an environmentally-related area of engineering and a background in the relevant area of social science, management, and law.

The degree of Environmental Engineer is a professional degree which goes beyond the Master's level but does not have the research emphasis of the doctorate. Students entering this program normally register in one of the engineering departments and plan their own programs of study which must be approved by a faculty advisor. Research facilities of the various engineering departments are used in support of the program.

PROGRAM REQUIREMENTS

Admission to the environmental engineering program is available by registering in any of the departments in the School of Engineering. General admission requirements include a bachelor's degree or equivalent from an acceptable college, university, or technical school with demonstration of an ability to accomplish a program of study and research.

The Environmental Engineer degree requires the completion of one hundred and sixty-two subject units. This includes sixty-six units in basic engineering, a minimum of twenty-five units in environmental engineering in one of three areas: air quality, water quality, or natural resource utilization, five subjects with at least forty-two units in environmental policy, up to twenty-nine units of electives and a thesis worth twenty-four units.

CURRENT FACULTY, STUDENTS, GRADUATES

Because of the interdepartmental structure of the program and the vast number of environmentally-related subjects offered in the School of Engineering, it is impossible to tell exactly how many faculty members are involved in the program. Faculty members of the School are responsible for research as well as teaching in their primary fields. Several sources provide research funding for the program, including the National Science Foundation, the National Aeronautics and Space Administration, the National Weather Service, the U. S. Geological Survey and the Rockefeller Foundation.

The program has a current enrollment of three full-time students. Most have backgrounds in civil or nuclear engineering physics. No specific recruiting is done by the program. Many students have come from master's programs in one of the engineering departments and become interested in environmental topics. Almost all students receive some form of finanacial assistance, primarily research assistantships. A few training grants and fellowships are also available.

An average of two to three students complete the program each year, and this number is expected to remain stable. Approximately fifty percent of the graduates work in the private sector, usually for consulting firms. The remainder find employment with government agencies or research work. Graduate placement is usually through students or faculty contacts with employers.

PROGRAM PROJECTIONS

No real expansion in the program or faculty is anticipated in the near future although program officials indicated that there is some need seen for an undergraduate program.

COURSE DESCRIPTION (SELECTED)

1.731 Water Resources Systems I - Introduction to the fundamentals of water resources systems analysis, involving the determination of the optimal dimensions, target out-puts, and operating policies of water resource projects. (3 s.h.)

1.77 Water Quality Control - Analysis of environmental engineering problems in water quality and pollution control technology. Emphasis on predicting the distribution and fate of effluents discharged into lakes, reservoirs, rivers, estuaries, and oceans. (3 s.h.)

1.78 Water Quality Management - Systematic approach to the management of water quality. Identification of major issues and problem areas. Type, sources, and stochastic nature of waste materials and their effect on water bodies. (3 s.h.)

1.811 Environmental Law: Pollution - Review and analysis of common law, legislation, and regulation for pollution control. Focus on programs, analytical and decision processes for controlling water, air, and noise pollution, and the emission of toxic materials. (3 s.h.)

2.284 Water Purification - An introduction to water resource, water quality parameters and pollutants. Outline of various water purification processes and economic considerations for water supply and wastewater treatment. (3 s.h.)

10.17 Air Pollution Fundamentals - Introduction to the causes, effects, and control of air pollution with emphasis on combustion generated pollution and industrial process sources; origin and fate of air pollutants; air pollution meteorology; combustion processes and the formation of gaseous and particulate pollutants; air pollution control principles; measurement methods for gaseous air pollutants and for particulates. (2 s.h.)

19.03 Meteorologic Aspects of Air Pollution - Primary emphasis on the physical processes involved with motion and dilution of material released into the atmosphere. (3 s.h.)

22.37 Environmental Impact Power Production - An assessment of the various environmental impacts of producing thermal and electric power with currently available technology. (3 s.h.)

INSTITUTION: MICHIGAN TECHNOLOGICAL UNIVERSITY (MTU)

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science in Civil Engineering (B.S.C.E.)
Bachelor of Science in Engineering (B.S.E.)
Master of Science in Civil Engineering (M.S.C.E.)

CONTACT: Dr. George K. Wadlin, Head
Department of Civil Engineering
Civil-Geology Building, Room 110
Michigan Technological University
Houghton, Michigan 49931
(906) 487-2520

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Students combine studies of chemical, biological and engineering backgrounds to understand and solve problems involving thermal pollution, emissions and air pollution, acoustics and sound abatement, water resources and quality and solid waste management. The program began in 1970. Courses are offered on a quarter system.

One of the five major areas of study in civil engineering at MTU is environmental engineering. Areas of concern are water collection, treatment and distribution, wastewater treatment, solid waste disposal, air pollution control, public health, watershed studies, reservoirs, water flow control, sediment transport, hydraulic machinery, irrigation dams and canals.

The B.S.C.E. is a well-rounded traditional civil engineering program in which the student may select approximately five technical elective courses in his/her field of study.

The B.S.E. is for those students who wish to concentrate their studies in the area of sanitary-environmental engineering. Each individual curriculum is developed by the student in consultation with the Professional Interest Group of the Civil Engineering Department. The student selects 25-30 technical elective courses to build a coherent environmental engineering program.

Major emphasis of the M.S.C.E. is water quality engineering and water resources engineering.

PROGRAM REQUIREMENTS

The Environmental Engineering Laboratories include 4,500 square feet equipped for studies of water quality and water and wastewater treatment processes. Major pieces of equipment include Treatment Process Pilot Plants, Beckman 915-A Total Organic Carbon Analyzer, Perkin Elmer 305-B Atomic Absorption Spectrophotometer, Gas Chromatograph, BOD Respirometer, soil penetrometer with loading frame. The Hydraulics-Water Resources Laboratory occupies about 6,000 square feet and is equipped for conventional hydraulic experiments and for meteorologic and hydrologic studies.

The environmental studies B.S.E. degree requires courses in the following areas:

Mathematics	26 quarter credits
Basic Science	40 quarter credits
Engineering Science	50 quarter credits
Engineering Analysis, design and system	40 quarter credits
Other courses	44 quarter credits

The M.S.C.E. requires 45 quarter credits and areas of emphasis are water resources engineering, water quality engineering, air quality engineering, or solid waste management.

The degree requirements for the 45 quarter credits are: 1) at least 18 credits must consist of 500 level courses; 2) not more than 18 credits can consist of 400 level courses; 3) 15 credits normally consist of Graduate Research (CE 500)--3-9 credits culminating in an engineering project report or 9-15 credits culminating in a thesis.

CURRENT FACULTY, STUDENTS, GRADUATES

Engineering disciplines are fully accredited by the Engineer's Council for Professional Development (ECPD). Four of 17 civil engineering faculty are directly involved in teaching the environmental courses.

Research funded has included U.S. Army Cold Regions Research and Engineering Laboratory, Corps of Engineers, National Science Foundation, Cleveland-Cliffs Iron Company, State of Michigan, Electric Power Research Institute, U.S. Department of Interior, and the Bureau of Mines. 1976-1977 funding was $584,000.

Undergraduates can participate in a co-op program during their junior and senior years. Thirty-five different companies and agencies offer opportunities for the students to receive valuable on-the-job training.

An undergraduate at MTU who has senior standing and who has a satisfactory undergraduate record may apply for permission to enroll in graduate study while completing the requirements for his bachelor's degree. Course credits earned after the application has been approved and not applied to the bachelor's degree may subsequently be applied toward an advanced degree. It is expected that a student accepted for early admission to a graduate program will complete all requirements for the bachelor's degree within 12 months.

	Enrollment	Graduates
B.S.E B.S.C.E.	135	25-35
M.S.E.S.	18	11

Types of graduate financial assistance are research assistantships (2), teaching assistantships, scholarships, cooperative arrangements with industry and hourly employment.

An alumni survey (1931-70) undertaken in 1971 showed that 11 percent of the 973 that returned usable questionnaires were involved in an environmental work area (sanitary engineering plus conservation and water supply).

PROGRAM PROJECTIONS

The faculty sees no change in the long-range goals and objectives of the program.

ADDITIONAL INFORMATION

An eight-member Industrial Advisory Committee was formed in April, 1977. Companies represented include Envirex, DuPont, Elzinga and Volkers, Inc., Lakeside Equipment, Department of State Highways and Transportation, Bechtel Associates Professional Corporation, Soil Testing Services of Wisconsin, Inc., Williams and Works. Members come from Michigan, Illinois, Delaware, and Wisconsin.

An annual summer program, "Women in Engineering," was held during 1977 for high school and transfer students. It began in 1973 and involves exposure to six fields of engineering plus applied technology and computer science through lectures and actual participation in laboratory projects. The lecturers are practicing women engineers from business, government, and industry. The only cost to the participants is transportation to and from MTU.

Participants are selected on a competitive basis. A strong background in math and science and an interest in technological studies is necessary. High school teachers and counselors are asked to recommend several female students who have the aptitude to engage in technological studies. High school science and math teachers as well as career counselors are also expected to participate in the workshops and learn more about engineering.

Three hundred forty-nine women from eleven states attended the three 1977 sessions which were each a week long. Fifty-three corporate friends and MTU sponsored the program. Instructional staff included women from Michigan Consolidated Gas Company, General Motors Corporation, Ford Motor Company, American Can Company, John Deere, Shell Companies, M. W. Kellogg Company, The Dow Chemical Company, Inland Steel Company, Black and Veatch Consulting Engineers, Upjohn Company, Sundstrand Corporation, Bechtel Corporation, Kimberly-Clark Corporation, 3-M Company, the Air Force, and MTU's School of Techology.

COURSE DESCRIPTION

Undergraduate:

CE104 Surveying I - Basic concepts and operations, quality measurements, distance and angular measurements, horizontal and vertical control, traverse computations. Use of transit, level, Geodimeter. Horizontal and vertical curves. (3 q.h.)

CE202 Civil Engineering II - An introduction to Fortran IV digital computer programming. Numerical analysis techniques. Problem-oriented computer languages. (3 q.h.)

CE351 Introduction to Environmental Engineering - A general survey of sanitary engineering covering water supply and sanitary sewerage systems, water and wastewater treatment, water quality, basic concepts of eutrophication of natural water, air pollution, solid waste disposal, and environmental health. (4 q.h.)

CE381 Soils Engineering - Study of the properties of soils and their application to the design of foundations and earth structures. (4 q.h.)

CE400 Professional Practice I - Presentation of the concepts and methods required to make decisions between engineering alternatives. (3 q.h.)

CE403 Professional Practice II - A study of the technique of preparing written and oral engineering reports. Study of types and purposes of engineering reports and lectures on engineering practice. (3 q.h.)

CE451 Water and Wastewater Treatment - Principles of physical, chemical, and biological processes employed in water and wastewater treatment. Design of selected individual units within water and wastewater treatment systems. (4 q.h.)

CE452 Examination of Water and Wastewater - Measurement of physical, chemical, and bacteriological parameters of water quality. Interpretation of these parameters with regard to the design and operation of treatment processes and to the control of the quality of natural water. (4 q.h.)

CE453 Environmental Impact and Protection - The relation of man's environment to public health and to its control from an

CE453 (Cont'd) - engineering viewpoint. Topics include the various federal and state laws and regulations pertaining to water quality, air quality, solid wastes and environmental impact. (3 q.h.)

CE454 Water Distribution and Wastewater Collection Systems - Application of basic courses in sanitary engineering and hydraulics to the analysis and design of water distribution systems, wastewater collection systems, and their appurtenances. (3 q.h.)

CE461 Hydraulic Engineering - A study of the hydraulics of flow in closed conduits and open channels including transitions and controls. Application to the hydraulic design of water supply, drainage and sewerage systems. (4 q.h.)

CE463 Hydrology - Study of relationship between rainfall and runoff as applied to water supply, water power, irrigation, soil erosion, and sanitary engineering. (3 q.h.)

CE464 Hydraulic Structures - The analysis and design of water-regulating structures including gravity dams, arch dams, earth dams, spillways, gates, stilling basins, and conduits. (3 q.h.)

ME104 Spatial Analysis - The theory of orthographic projection as related to the graphical solution of space problems. Elements of descriptive geometry involving space relationships of points, lines, planes, and surfaces. (3 q.h.)

ME431 Thermal Pollution - The course emphasis is on the application of thermodynamics, heat transfer, and fluid mechanics to the evaluation and control of thermal pollution. Laboratory experiments and field trips are included to assist in obtaining a proper perspective. (3 q.h.)

ME433 Noise Control Engineering I - Both theory and practice are emphasized in this course, which introduces the student to the analysis and measurement of sound and vibration as applied to noise control. The basic concepts of vibration and acoustic theory are developed and a variety of sound and vibration measuring equipment is used in laboratory experiments. The student works on team projects analyzing some actual noise problems. Special topics from the current literature in acoustics and noise control are presented. (4 q.h.)

ME435 Emissions and Air Pollution - The Federal Clean Air Act and the technical aspects of standards resulting from this act are studied including the technical approaches for meeting these standards. Control methods for mobile and stationary sources are studied. In addition, the theory for atmospheric dispersion from stationary stacks is developed and applied to a number of engineering problems. Measurement techniques for ambient, mobile, and stationary source emissions for hydrocarbons, carbon monoxide, ME435 (Cont'd) - nitrogen oxide, nitrogen dioxide, oxygen, particulate matter, and sulfur oxides are covered. (3 q.h.)

Graduate:

CE551 Solid Waste Management - A study of the quantity, characteristics, and handling of municipal solid wastes. Topics include current federal and state regulations, the analysis of collection operations, sanitary landfill design, and various resource recovery alternatives. (3 q.h.)

CE552 Industrial Waste Treatment - Study of the sources and control of water pollution from industrial waste. Topics include characteristics of major industrial wastes, waste reduction through water conservation and reuse, selected treatment processes, and joint treatment of municipal and industrial wastes. (3 q.h.)

CE553 Advanced Sanitary Engineering I - Advanced analysis and design of the physical, chemical, and biological processes employed in water and wastewater treatment. Emphasis is placed upon laboratory evaluations and on the scale-up of laboratory data for the design of water treatment systems. (4 q.h.)

CE554 Advanced Sanitary Engineering II - Continuation of CE553. Emphasis is placed upon laboratory evaluations and on the scale-up of laboratory data for the design of biological waste treatment systems. (4 q.h.)

CE555 Water Quality Hydrology - Examination of the effects of effluent discharges and runoff on surface and groundwater supplies. Emphasis is placed on describing and predicting the effects in quantitative terms. Methods for controlling and minimizing deleterious effects also are stressed. (3 q.h.)

CE556 Advanced Sanitary Engineering III - Continuation of CE554. Emphasis is placed upon laboratory evaluations and on the scale-up laboratory data for the design of advanced waste treatment and nutrient removal systems. (4 q.h.)

CE564 Water Resources Engineering - Advanced topics related to water resources engineering including: multiple purpose river development, economic analysis of river development, aspects of water law, and administrative aspects of water resources planning. (3 q.h.)

CE591-4 Seminar - Detailed study and group discussion of current literature and graduate research projects related to the broad field of civil and environmental engineering. Normally, several sections will be offered depending on the student's area of interest: environmental and water resources, structures, soils, construction, and transportation. At times, joint sessions will be held on subjects of general interest. (1 q.h. each)

INSTITUTION: MIDDLESEX COUNTY COLLEGE

PROGRAM: Environmental Health Science Technology

DEPARTMENT: Science Division

DEGREE: Associate of Applied Science (A.A.S.)

CONTACT: Diane Trainer, Chemistry Department
Middlesex County College
Edison, New Jersey 08817
(201) 548-6000 extension 241

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Middlesex County College initiated its Environmental Health Science Technology Program in 1971 to train technicians as: laboratory technicians to perform air, water, and wastewater analyses; water and wastewater treatment plant operators, air pollution inspectors; stack samplers; public health enforcement officers (sanitorians and food and drug inspectors); and industrial hygiene technicians. Emphasis is placed to produce graduates with both flexibility and adaptability so they are able to work in more than one pollution control and abatement area.

This two year program stresses environmental laboratory training, and courses are integrated from biology, chemistry, physics, microbiology and other areas. The program offers advantages to students of low tuition, modern equipment and facilities, personalized laboratory supervision, and faculty with teaching and industrial experience.

PROGRAM REQUIREMENTS

In order to enter the Environmental Health Science Program, a prospective student must be a high school graduate, have one year of laboratory science and one year of Algebra. Structured into the two year, four semester curriculum are sixty-four credits of courses which include water and wastewater treatment, environmental microbiology, air pollution control, sanitary chemistry, industrial hygiene, and community sanitation. Six credits of humanities and social science electives must be taken within the present structure.

In the second semester of the second year, the students are employed for one day each week. However, they are not salaried and their primary function is one of observation. One college credit is received for their participation in this internship program. A log is kept by the student of the activities in which they participated and at the end of the period, the students immediate job supervisor writes an evaluation of the student's performance. This internship program has often enabled students to use the evaluations as letters of recommendation when later searching for employment or being offered jobs by their internship employer.

Financial aid from the State of New Jersey is available to students and a few receive work-study funding. Students also have access to other federal programs such as the Educational Opportunity Fund, ROTC, and the Basic Educational Opportunity Grant Programs.

CURRENT FACULTY, STUDENTS, GRADUATES

Four faculty members currently teach concepts of environmental science to students enrolled in the Environmental Health Science Program and all are full-time. The Program currently has an enrollment of 19 students, full-time, and four part-time. Four of the full-time students are female. Since the program was initiated in 1971, there has been a consistent graduating class of fifteen students.

About forty percent of the annual graduates transfer into other college or university environmental programs. Middlesex Environmental Health Science graduates often attend Bachelor degree programs offered by Rutgers, Stockton State College, Ramapo State College, New Jersey Institute of Tehcnology, Michigan Tech, and San Jose State College. The College maintains a placement service and a job counselling service to assist students in their employment search. Program officials estimate that of ten total graduates, six find employment and four are college transfers. Of seven 1976 graduates surveyed by the College in 1976, six found employment in their field and one in a related field. Only one of the seven found employment with a governmental agency.

PROGRAM PROJECTIONS

Although College officials project that environmental programs are continuing to increase in number and size, the emphasis is mainly in specific areas, e.g. industrial hygiene, energy, and water. There are no current plans being made by College officials to expand the Environmental Health Science Technology Program because no real need exists at present. However, due to an increased enrollment, one additional faculty member will be recruited in 1978 to teach environmental science and chemistry courses.

COURSE DESCRIPTION

ENV 201 Advanced Wastewater I - Covers such topics as wastewater characteristics, flow measuring devices, physical treatment systems, and sludge digestion and disposal. (3 s.h.)

ENV 202 Advanced Wastewater II - Covers an approach to total treatment of wastewater. Prepares a student for the NJ State Wastewater Operators License. (3 s.h.)

ENV 203 Advanced Water Operations I - Sources of water and their characteristics, water cycle balance, reservoirs in NJ, surface and ground water supplies, methods of analysis, disinfection, tastes, and odors. (3 s.h.)

ENV 204 Advanced Water Operations II - Water treatment operations including pretreatment and filtration, distribution systems, records, budgeting, and supervision. ENV 203 and 204 must be taken to prepare a student for the NJ State Water Operators License. (3 s.h.)

ENV 205 Atmospheric Pollution - Community air pollution, stressing problems and the technology used for their detection and control. (3 s.h.)

ENV 207 Concepts of Environmental Science - A one-semester course for the career-oriented student that explores the possible causes and cures of all types of pollution in our society. (3 s.h.)

ENV 208 Community Sanitation - A survey of current community and environmental health problems with emphasis on communicable diseases, waste disposal, water and air pollution control, food sanitation and radiological health, and other topics. (3 s.h.)

ENV 211 Environmental Science I - Emphasis is on the water and air environment. Includes laboratory and field trips. (4 s.h.)

ENV 212 Environmental Science II - Focuses on solid wastes, noise, energy, radiation, and other miscellaneous environmental areas of concern. (4 s.h.)

ENV 222 Water and Wastewater Analysis - A systematic study of laboratory procedures as applied to water analysis and purification. (3 s.h.)

ENV 250 Environmental Internship - One day per week exposure to an environmental career. (1 s.h.)

ENV 220 Industrial Hygiene - This course examines the sampling and analytical techniques required to evaluate the safety and health hazards associated with the industrial environment. (3 s.h.)

INSTITUTION: MUSKINGUM AREA TECHNICAL COLLEGE (MATC)

PROGRAM: Environmental Quality Control Technology (air and water options)
DEPARTMENT: Division of Engineering and Science
DEGREE: Associate of Applied Science

CONTACT: Mr. Charles M. Woolf, Division Chairman
Division of Engineering and Science
Muskingum Area Technical College
1555 Newark Road
Zanesville, Ohio 43701
(614) 454-2501

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Quality Control Technology program offered at Muskingum Area Technical College is designed to train paraprofessionals to meet manpower needs necessitated by stricter legislation and enforcement of environmental quality standards. Graduates receive an Associate of Applied Science degree preparing them to work with professional biologists, chemists, engineers, and environmentalists in conducting air and water quality studies. Their work includes the collection and analysis of air and water samples for routine monitoring, special studies, and for insuring compliance with environmental quality laws.

During the second-year of this two-year program, students may choose two technical electives that provide them with a more intensive training in either air or water quality. However, students are now encouraged to take the technical electives under both options; and all students currently enrolled do so. All other coursework for the two options is identical. The college maintains analytic and mobile laboratories for each option area all equipped with a broad spectrum of instrumentation. The air laboratories permit meteorological and air sampling tests while the water quality labs allow water testing. Students learn to maintain and operate all of the equipment in these laboratories (10 to 15 percent of the equipment was donated by the Environmental Protection Agency). The meteorological recording station is the only one in a five-county area. Nearby industries cooperate in on-site visits by students to their facilities.

Environmental Quality Control Technology faculty have conducted workshops for the Ohio Environmental Protection Agency in the area of particulate analysis (air) and for high school students and teachers on more general topics. State certification in microbiological particulate analysis is almost complete, and work toward certification in inorganic analysis will begin soon. As a service to public agencies, the program also sponsors a testing lab for the National Pollution Discharge Elimination System (NPDES) which gives students experience while in school for jobs upon graduation.

Curriculum oversight is provided by an advisory committee of local citizens in the environmental quality field. All students intern during the summer months in some form of employment related to their particular technological interests and receive college credits for this work. The environmental program presently has a special intern on-the-job arrangement with the City of Zanesville for outstanding students.

PROGRAM REQUIREMENTS

To obtain the Associate of Applied Science in either Air or Water Quality, the student must complete 110 quarter hours in basic sciences, mathematics, communication, social sciences, and, of course, environmental sciences. Admission to MATC requires a high school diploma or its equivalent.

CURRENT FACULTY, STUDENTS, GRADUATES

Two faculty members serve the 23 first-year and 13 second-year students currently enrolled in the program. The statistics on program graduates (six in 1976, nine in 1977) indicate an increasing number of students who are completing this course of study. Financial assistance consists of standard programs such as Basic Educational Opportunity Grants, Ohio Instructional Grants, College Work-Study, National Direct Student Loan, Supplemental Educational Opportunity Grants, and Ohio Student Loans.

On the average, over two-thirds of the Environmental Quality Control graduates gain employment in their technological field. There are no reported problems with placement though the faculty note that available positions in municipalities, consulting firms, industry, and the Environmental Protection Agency are limited to those requiring two-year graduates. The college cannot fill all the water and wastewater jobs listed at MATC. Employment opportunities come through the college placement office (each technology has its own placement officer), the student's internship experience, and the program's advisory committee. Jobs are available to graduates of this program in public health departments, pollution control equipment manufacturing, municipal water and wastewater treatment facilities, federal and state fish and wildlife departments, U.S. Corps of Engineers, private consulting firms, research laboratories, private industries, federal and state Environmental Protection Agency offices, and local environmental control boards.

PROGRAM PROJECTIONS

The faculty of the Environmental Quality Control department predict a stable future for their program. Depending on decisions by the Environmental Protection Agency and changing career opportunities, the program may shift toward more water-related courses (water distribution, wastewater, etc.). An additional staff member in biology will have to be hired in the next five years to meet enrollment demands.

A major concern of the staff at MATC is the lack of employer awareness of the capabilities of the two-year technician who has both practical skills and theoretical knowledge. Staff personnel contend that public support, training monies for students and workshops, and increased enrollments are essential in order to maintain the current environmental programs in the State of Ohio.

COURSE DESCRIPTION *

BIOL 141 Field Zoology and Ecology - A study of the animals common to this area, stressing identification and the environmental aspects which affect their distribution. The basic principles of ecology are covered with emphasis on the interrelationships between an animal and his physical and biological surroundings. (3 q.h.)

ENV 111 Industrial Processing and Pollution Control I - Prime emphasis will be the study of major manufacturing and industrial processes and products with orientation towards the origins of the pollutants and the engineering problems involved in their control. Each industry's air, water, and solid waste problems will be studied from the industrial engineer's viewpoint with emphasis on a total solution. (3 q.h.)

ENV 151 Introduction to Environmental Quality Problems - An introduction to environmental pollution, its effects on man, other animals, and plants. It includes discussion of the major pollution sources, and health and economic problems created by pollutants. (3 q.h.)

ENV 135 Earth Science - A study of the physical principles guiding the earth's development, including basic geology, weathering and land forms; the method of locating points on the earth and principles of mapping; principles of meteorology; interactions of abiotic and biotic components of the environment. (3 q.h.)

ENV 112 Industrial Processing and Pollution Control II - This is a continuation of ENV 111 looking at major industries and their unique problems associated with pollution control. (3 q.h.)

CHEM 111 Chemistry--Basic and Organic - designed to introduce the students to the basic principles of chemistry, atomic theory, CHEM 111 (Cont'd) - chemical bonding, reactions, and other aspects of preparatory chemistry. This course specifically meets the needs of field analysis and laboratory in environmental quality control. It will include studies of organic compounds as pollutant compounds. Laboratories will include testing techniques specific to environmental quality control. (4 q.h.)

ENV 121 Air Sampling and Analysis - A study of the standard techniques of ambient air sampling. This course shall include an understanding of the principles of operation and maintenance of air sampling equipment; an understanding of the analytical (quantitative and qualitative) techniques used to identify and measure air pollutants; experience in site selection and in collection of various types of air samples; practical experience in laboratory analysis of air samples by the standard methods of wet chemistry, colorimetric method, and instrumental analysis; and the interpretation of data collected and analyzed by the students. (4 q.h.)

ENV 171 Water Sampling and Analysis - The course is designed to give practice in water sampling techniques and chemical analysis (wet chemistry, instrumental analysis, and by portable test kits) of the water quality of streams and lakes. It also includes studies of new methods, techniques, instruments in field sampling and laboratory analysis, data interpretation, and reporting results. (4 q.h.)

ENV 251 Environmental Quality Laws and Enforcement - An analysis of existing environmental quality control laws, methods of establishment, and the enforcement practices of the different governmental agencies. (3 q.h.)

NS 200 Internship - Supervised work experience required for environmental sciences students. Includes student applying for job in related area, on-the-job supervision, scheduled visits by coordinators, and periodic evaluations. (7 q.h.)

NS 299 Seminar - Course taken in conjunction with Internship. Includes discussion of students' intern experiences, principles of employment practices, and improvement of employee traits. (3 q.h.)

ENV 271 Environmental Instrumentation - An introduction to the types of measuring means and their function, their operation, practical construction, and uses. Instrumentation terminology and measuring devices for temperature, flow rates, level control, pressure, other control devices, monitoring, and recording instruments are studied. (4 q.h.)

ENV 291 Water Treatment Techniques - The course is designed to provide the formal training to allow the student to attempt the State of Ohio Class One Operator Water Exam. The course will emphasize sources, water softening, water hygiene and

ENV 291 (Cont'd) - public health aspects, distribution systems, types of equipment and treatments, and budgetry. (4 q.h.)

ENV 235 Environmental Science Computer Applications - Introduction to computing sciences for the analysis and interpretation of environmental data and computer print-out. Simple statistical treatment of data is combined with the utilization of simple calculators, programmable calculators, the PDP-8 terminal computer, and the IBM 360-30 computer. Simple programming is combined with other computer operations such as keypunching and sorting, and the use of pre-programmed packages. (3 q.h.)

ENV 281 Environmental Health - An investigation into the activities of the state and local health departments including their role in setting environmental standards and methods of inspection for water, wastewater treatment facilities, air quality monitoring, insect vector and rodent control, pesticide use, radiation safety, milk and food service, and communicable disease control. (4 q.h.)

ENV 211 Emission Control Techniques - A study of industrial and vehicular emissions, presenting the fundamental principles of gravitational settling, inertia, filtration, absorption, and combustion applicable to control of various pollutants at their sources with odor and noise control. (3 q.h.)

BIOL 151 Field Botany and Ecology - A study of the structure and life processes of plants, the classification and identification of plants, and the basic principles of plant ecology stressing the environmental affects on the morphology, physiology, and distribution of plants. (3 q.h.)

ENV 215 Wastewater Treatment Techniques - The course is designed to provide the training to permit the student to apply for the State of Ohio Class One Operator Wastewater Exam. The course will emphasize types of treatment and equipment, wastewater hygiene and public health aspects, sewer systems, and budgetry considerations. (4 q.h.)

ENV 225 Stack Gas Sampling and Analysis - The course stresses the basic techniques in source sampling at the stack and the specific analytical techniques required. It also includes the areas of monitor design, isokinetic techniques, and continued vs. periodic sampling techniques. Experiences are gained through practical lab and field work. (3 q.h.)

Technical Electives - Air Option:

ENV 285 Blueprint Interpretation - An introduction to the theory of projection and dimensioning as related to working drawings and blueprints. Development of ability to interpret shape, ENV 285 (Cont'd) - size, position, and functional relationships of structures and mechanisms from blueprints. (3 q.h.)

EE 251 Introduction to Electricity/Electronics - A study of the fundamentals of the science, the how and why circuits behave as they do and their relationship to common devices. Provides an introduction to electricity/electronics. (3 q.h.)

Technical Electives - Water Option:

ENV 265 Microbiological Techniques - The basic techniques in culturing and identifying microorganisms, with emphasis on the bacteriological techniques used in water quality analysis and the environmental health field. (3 q.h.)

ENV 275 Aquatic Organisms - Identification and classification of common aquatic life from microorganisms to vascular plants and vertebrates; ecological relationships, environmental needs and responses to change, and the use of diversity index and indicator species. (3 q.h.)

* courses are listed in the sequence taken by the student

INSTITUTION: NEW JERSEY INSTITUTE OF TECHNOLOGY

PROGRAM: Interdisciplinary Studies in Environmental Engineering
DEPARTMENT: Interdepartmental
DEGREE: Master of Science (M.S.)

CONTACT: Dr. Eugene Golub
Chairman, Dept. of Civil and Environmental Engineering
New Jersey Institute of Technology
323 High Street
Newark, New Jersey 07102
(201) 645-5321

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Because of the need for interdisciplinary approaches to environmental problems, New Jersey Institute of Technology offers a program for students of various backgrounds and interests. The program began four years ago and is offered in addition to an environmental option in civil engineering.

Program administration is accomplished by the Environmental Engineering Committee, an inter-departmental faculty group. Five specializations are offered in the program: industrial waste, pollution control, water resources and water treatment, municipal waste treatment, air pollution control, and solid waste management. Students follow a curriculum approved by a faculty advisor and take courses offered by various departments, primarily civil and environmental engineering, chemical engineering, and mechanical engineering.

Support facilities include the laboratories of the various engineering departments.

PROGRAM REQUIREMENTS

Admission to the program requires an undergraduate degree in engineering, normally from an ECPD addredited Program. It is also recommended that the applicant take the aptitude test and advanced portions of the Graduate Record Examination.

For the M.S. degree, each student must complete eighteen credits of specialization, twelve credits of electives including six credits outside the department of specialization, and a thesis. Each student must also take the following courses: environmental chemistry and legal aspects in environmental engineering.

A student may select courses, with the assistance of the faculty advisor, to fulfill the specialization and elective requirements. The student normally selects courses recommended for one of the five specializations. He can, however, select courses in more than one specialization or from other departments, in line with his career objectives and prior preparation.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently a total of ten faculty members, all full-time, participating in the program. They divide their time equally between teaching and research. Research is normally performed in the department of the faculty member involved and funding is provided primarily through EPA research grants and the New Jersey Department of Environmental Protection.

A large majority of the students in the program, about 96 percent, come from New Jersey. Little direct recruiting is done for the program and most students become aware of it through other students or faculty. Current sources of student financial support include teaching assistantships, research assistantships, and fellowships.

Although no formal follow-up is done on program graduates, officials indicated that most find employment within the private sector. Jobs are usually found through individual contact by the student or faculty members or through the school's placement service.

PROGRAM PROJECTIONS

Program officials see a need for expansion of the curriculum and in number of students, but feel it is unlikely that this will occur in the near future because of financial reasons.

COURSE DESCRIPTION (SELECTED)

ChE 685 Unit Operations for Industrial Waste Treatment - A course which introduces the student to basic concepts of unit operations which are applicable to the treatment of industrial effluent streams and for municipal waste water advanced treatment. (3 s.h.)

ChE 686 Industrial Waste and Control - The industrial processes and the resulting waste problems associated with key industries are examined. (3 s.h.)

EnE 560 Environmental Chemistry - Basic physical and chemical principles applicable to environmental and sanitary engineering are presented and amplified in the laboratory. (3 s.h.)

EnE 660 Introduction to Solid Waste Porblems - An introductory course in solid waste disposal which covers industrial and urban sources of solid waste and the conventional methods of disposal of these wastes. (3 s.h.)

EnE 663 Pollution: Chemistry and Ecology - This course considers the nature and effects of pollution as it relates to air, water, and soil, and the inhabitants of these areas. Pollution prevention and current pollution research is studied. (3 s.h.)

EnE 668 Air Pollution Control - The nature of the air pollution problem, its effect on the public at large, and the present legal and engineering controls used to combat the problem are considered. (3 s.h.)

EnE 671 Environmental Impact Analysis - Overview of environmental problems, federal and state standards, methodology for developing impact statements, case studies based on recent experience, basis for assessment and decision-making. (3 s.h.)

EM 631 Legal Aspects in Environmental Engineering - A study of the power of the federal, state, local governments and international law in pollution control of air, water and solid wastes. (3 s.h.)

ME 660 Noise Control - A study of engineering methods for reducing noise pollution including reduction of intensity at the source, limitation of transmission paths and absorption; applications to structures, machinery, ground transportation, and aircraft; and noise measurement. (3 s.h.)

ME 661 Thermal Pollution of Water and Air - Study of sources and processes causing thermal pollution and their effects on the environment; study of heat exchange mechanisms between water and air with emphasis on thermal pollution of rivers, streams, lakes and reservoirs; design of cooling ponds and towers; and use of instruments and techniques in thermal pollution control. (3 s.h.)

ME 662 Air Pollution Control and Design - An investigation of the techniques utilized for the solution of air pollution problems. (3 s.h.)

INSTITUTION: NORTHEASTERN UNIVERSITY

PROGRAM: Environmental Engineering and Science

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.)

CONTACT: Dr. John J. Cochrane
Chairman, Department of Civil Engineering
Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115
(617) 437-2444

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental Engineering and Science at Northeastern prepares students for professional occupations in the water and wastewater fields. The graduate program began as an evening program for part-time students in 1952 and added a day program in 1965.

The program comprises four areas of specialization from which a student may select, including water and wastewater engineering, environmental health engineering and science, water resources engineering, and air pollution engineering. Courses are offered in both day and evening and a cooperative program is available in which a student spends two quarters of the first year and one quarter of the second year in the academic program and the remaining quarters plus the summer following the first year in professional employment. Both an M.S. degree in Civil Engineering and an M.S. without specification are awarded by this program.

Program support facilities include a water pollution control laboratory which is capable of analyzing water and wastewater samples in physical, chemical, and biological regimes, and an air pollution laboratory capable of sampling ambient air, gaseous and particulate pollutants, and evaluating the physical, chemical, and biological characteristics of atmospheric pollutants.

PROGRAM REQUIREMENTS

Admission to the program for the M.S. degree in Civil Engineering requires a B.S. degree in Civil Engineering, with an acceptable quality of undergraduate work, from a recognized institution. For the M.S. degree, applicants may have a B.S. degree from a recognized institution in some other engineering field or related science and an appropriate background of preparation.

Requirements for the Master's degree include forty quarter hours of course work and a master's report worth four quarter hours of credit or a thesis worth eight quarter hours. A student must select one of the four areas of specialization and complete all courses required for that specialization. In addition, fourteen quarter hours of electives must be obtained from the environmental engineering courses offered by the Civil Engineering Department.

CURRENT FACULTY, STUDENTS, GRADUATES

There are presently nine faculty members in the program and they are responsible for teaching about three-quarters of their time and for research during the remainder. Funding for research is currently provided by EPA and the State of Massachusetts.

Currently there are two hundred and forty five evening students and sixteen day students. Most students are Boston area residents and are recruited through informal means. Northeastern is one of few schools in the area with an evening graduate program in environmental engineering. Presently, five students have EPA training grants and four receive University assistantships. There are also four students in the cooperative program.

Approximately thirteen students graduate from the day program each year and about thirty M.S. degrees are awarded to evening students. These numbers have remained constant over the past years and are expected to continue. Placement of graduates is not considered to be a significant problem since most are already employed while in the program. Most graduates are employed in the private sector or with government agencies.

PROGRAM PROJECTIONS

Program officials hope to expand the program with the addition of courses and an increase is research. Specifically, they would like to expand efforts in environmental planning and computer aspects of environmental control. This would probably require an additional two faculty members in the next two or three years.

COURSE DESCRIPTION

1.907 Environmental Statistics - Statistical studies applied to environmental data, including basic statistics; frequency and probability distributions; methods of frequency analysis; multiple linear regression and correlation analysis; introduction to mathematical modeling of environmental processes including discussion of deterministic and stochastic processes. (2 q.h.)

1.908 Hydrology I - Hydrologic cycle; precipitation studies incluing data adjustment, spatial and temporal variability, intensity-duration-frequency relationships; abstractions of water due to evapotranspiration and infiltration; groundwater flow, including flow nets and well hydraulics; and other topics. (4 q.h.)

1.910 Water and Wastewater Treatment I - Water qulaity, water impurities and effects, the theory and practice of water treatment, and the elements of design of water treatment works including intake facilities, wells, filtration, coagulation, sedimentation, softening, iron and manganese removal, disinfection, and fluoridation. (2 q.h.)

1.913 Industrial Waste Disposal - Evaluation of industrial waste problems and development of process design for the required treatment facilities; study of various manufacturing processes and their wastewater problems; industrial waste survey techniques; characteristics of industrial wastes; waste reduction methods; physical, chemical, biological, and advanced treatment methods; industrial wastewaters and disposal and treatment of industrial solids and liquids. (2 q.h.)

1.950 Air Pollution Engineering - Theory and practice related to envineering management of air resources; applications of models for the atmospheric dispersion of pollutants; analysis of control systems for gaseous and particulate emissions utilizing dry collection, wet collection, absorption, and catlytic processes. (2 q.h.)

1.952 Industrial Hygiene - Characterization and control of industrial problems associated with noise, hearing and ventilation. Physical and biological aspects of environmental stress are discussed. Emphasis is placed on the application of engineering principles to the design of control systems. (2 q.h.)

1.957 Air Pollution Science - Biological and chemical aspects of air pollution with emphasis on the toxicological aspects of the environment, physiological effects of aerosols, analysis of organic and inorganic constituents of the atmosphere and rationale for establishment of air quality criteria and standards. (2 q.h.)

1.985 Environmental Protection - Environmental quality and its effects on health, comfort, aesthetics, balance of ecosystems and renewable resources; interaction of the water-land-air complex, vector control, food protection, ionizing radiation, other radiation, and the energies of heat and sound. (2 q.h.)

INSTITUTION: NORTH CAROLINA STATE UNIVERSITY

PROGRAM: Air Conservation

DEPARTMENT: Interdepartmental

DEGREE: As only a minor is offered in Air Conservation, the degree earned varies with the student. The minor is offered at the master's and doctoral level.

CONTACT: Dr. David Marsland, Chairman
Air Conservation Faculty
Department of Chemical Engineering
North Carolina State University
Raleigh, North Carolina 27650
(919) 737-2325

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This multi-disciplinary program provides training for students in the many fields related to air conservation. Course offerings and research projects cover such areas as air sampling, biological effects, air quality management, sources, meteorology, law, economics and business. Courses may be taken on campus as well as at the University of North Carolina at Chapel Hill or Duke University. Relevant courses at North Carolina State University are offered in such departments as Civil, Chemical and Mechanical and Aerospace Engineering; Meteorology; Statistics; Chemistry; Forestry; Toxicology; Wood and Paper Science; Politics; Economics and Business; and Operations Research.

The minor in Air Conservation was first offered in 1971; although begun with an EPA training grant, these funds are no longer available. The program was designed to train students for a variety of environmentally related job opportunities in both the public and private sectors. Students are offered the opportunity to acquire the expertise necessary to become environmental officers specializing in air pollution control in governmental regulatory agencies, as well as in industrial plants and consulting engineering firms.

PROGRAM REQUIREMENTS

Although a student must have earned a bachelor's degree to work towards a graduate minor, advanced undergraduates may take selected courses. Students minoring in Air Conservation should have a strong background in the life sciences, the physical sciences, or engineering. The minor program normally consists of nine or more semester credits for the master's degree, fifteen or more for the doctorate. A graduate student desiring this minor has on his/her advisory committee a member of the Air Conservation faculty from outside the individual's major department. The courses taken by each student are subject to the discretion of this faculty advisor, and vary with the student's major field and employment goals.

CURRENT FACULTY, STUDENTS, GRADUATES

Thirty-nine faculty members from nineteen departments and four schools provide support to the Air Conservation program. Approximately 30 percent of this effort goes toward teaching, the remainder toward research. All of these faculty members work part-time with this program; the full-time equivalent faculty for Air Conservation is estimated at ten. Related research is carried out within the respective contributing departments.

There are an estimated ten students currently working toward obtaining a master's degree with this minor. Approximately five students per year obtain a degree with the Air Conservation minor. Little information is available regarding graduate placement at the present time. Four of the five students supported by the initial training grant became employed by public agencies in jobs related to air conservation. Those with engineering degrees are most likely to become employed by private concerns.

PROGRAM PROJECTIONS

Officials do not project that significant changes will take place within this program, or that a major in this field will be offered. The chief reason for this forecast is that employment needs are not seen for such graduates. The number of students with the currently offered minor is expected to remain relatively stable, as is the number of contributing faculty members.

COURSE DESCRIPTION

(Selected relevant courses offered at North Carolina State University)

CE 576 Atmospheric Pollution - A survey of the problem of atmospheric pollution. Topics include: pollutant sources; effects on humans and other animals, vegetation, materials and visibility; meteorological factors; air sampling; control devices; air quality and emission standards; legal, economic and administrative aspects. (3 s.h.)

MY 512 Micrometeorology - Meteorology of the lowest hundred meters of the atmosphere with emphasis on the transport of momentum, heat, water vapor, and effluents and their transfer through the earth's surface. (3 s.h.)

MY 555 Meteorology of the Biosphere - Physical principles governing the states and processes of the atmosphere in contact with the earth's surface of land, water and life. Exchanges of heat, mass, momentum are analyzed for various conditions of the atmosphere and surface, and as a function of season, time, and geographic location. (3 s.h.)

MY 556 Air Pollution Meteorology - The meteorological aspects of air pollution, especially for non-meteorologists engaged in graduate training for work involving air pollution. (3 s.h.)

MY 627 Atmospheric Turbulence and Diffusion - Mechanics of turbulence in the atmosphere, spectra and scales of atmospheric turbulence, and magnitudes of turbulent fluctuations. Theories of diffusion in the atmosphere. Diffusion and transport experiments. Processes other than natural turbulence affecting concentration of effluents. (3 s.h.)

CH 517 Physical Methods of Elemental Trace Analysis - Pulse polargraphy, potentiometry, UV-Vis spectrophotometry, atomic absorption, emission spectrometry, flourescence, neutron activation, analysis, and spark source mass spectrometry. (3 s.h.)

FOR 353 Air Photo Interpretation - Theory, principles and techniques of utilizing air photos as data sources for planning and management of renewable resources. Stereoscopic identification and examination of the bioecological factors of terrain, plants, growing conditions, water, wildlife and the changes brought about by human activities. (3 s.h.)

BO 480 Air Pollution Biology - The effects of air pollutants on biological systems at the subcellular, cellular, tissue, organ, individual and community level. (3 s.h.)

CE 472 Elements of Air Quality Management - Pollution and community air quality management, including pollutant sources, effects on biological systems, materials, and the atmosphere; meteorological factors; air sampling; abatement and control techniques; air quality and emission standards; and legal, economic, and administrative aspects. (3 s.h.)

CHE 535 Engineering Economy in Air Pollution Control Systems - Principles and practices in designing equipment for the abatement of air pollution; estimation of capital cost and operating expense; economic optimization under tax laws. (3 s.h.)

MAE 409 Particulate Control in Industrial Atmospheric Pollution - Combustion calculations and analysis of particulate emissions and gases from industrial and utility power stations burning various types of fuel. Pollution codes, requirements for compliance and enforcement. Calculations and design of industrial equipment. Utilization of waste products. (3 s.h.)

MAE 570 Theory of Particulate Collection in Air Pollution Control - Classification and description of particulates and their motions. Elements of aerodynamic capture. Fundamentals of acoustical, electrostatic and thermal precipitation. Sampling techniques and instrumentation. (3 s.h.)

WPS 525 Pollution Abatement in Forest Products Industries - Pollution sources, inplant control and treatment of water and air pollution in forest products. (3 s.h.)

INSTITUTION: NORTH DAKOTA STATE SCHOOL OF SCIENCE

PROGRAM: Environmental Science Technology

DEPARTMENT: Technical and Trade Division

DEGREE: Applied Science (A.S.)

CONTACT: Mr. Samuel Schimelfenig, Director
North Dakota State School of Science
800 North 6th Street
Wahpeton, North Dakota 58075
(701) 671-1130

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Science Technology (EST) program, begun in 1971, is multi-disciplinary in nature and requires two years of training. It was developed through a state grant for $3,000. This training is seen as an end in itself, enabling the student to achieve technical and trade competencies for immediate employment. Until recently all trade-technical training for the State of North Dakota was centralized at North Dakota State School of Science.

Environmental Science Technology shares a common curriculum with Civil Technology for the initial year. Specialization occurs in the second year, and areas of emphasis for EST are environmental pollution problems, liquid waste, solid waste, and air pollution.

PROGRAM REQUIREMENTS

A high school transcript and ACT score or other nationally recognized tests are needed for admission.

Minimum general education requirements in the technical division are English (9 quarter hours), Mathematics /Science (11 quarter hours), Social Science and Psychology (6 quarter hours), and Health and Physical Education (1 quarter hour). The A.S. Degree requires 123 quarter hours.

CURRENT FACULTY, STUDENTS, GRADUATES

The seven men who teach the courses are from the various subject areas of the school's technical divisions.

One student presently has declared a major in EST. The possibility exists that seven other could choose this program when majors are declared next fall.

Better than 80 percent of the students receive some type of financial support. The occupational placement office and mass mailings to employers have proven to be excellent resources in the placement of graduates.

PROGRAM PROJECTIONS

The technical division's enrollment is increasing, but this is not true for the Environmental Technology program. Because of the declining number of students enrolling in this program, the long-range goals and objectives may have to be changed. The need for land reclamation in mining areas generally and, particularly in, the coal fields of western North Dakota are seen as two new areas of concern.

ADDITIONAL INFORMATION

Workshops and seminars have been conducted for the state health department to upgrade skills for the participants in their present jobs. NDSSS faculty and people from industry teach the 12 session courses that meet once a week.

COURSE DESCRIPTION (all are required)

ES201 Introduction to Pollution Control - The study of classes and sources of pollution and its effects on our health, animal and plant life together with methods of its prevention and control. (2 q.h.)

ES202 Air Pollution Control - The study of classes, sources, measurements and the meteorology of air pollution and its effects on our health, animal and plant life together with methods of its prevention and control. (4 q.h.)

ES203 Air Pollution Control - The study of the principles and operation of sampling instruments, surveys and sampling techniques, control devices, and the legal aspects of air pollution. (4 q.h.)

ES206 Solid Waste Disposal - The study of the classes and sources of solid wastes together with methods of its handling, storage and disposal. (3 q.h.)

ES207 Sanitary Chemistry and Biology - A rigorous survey course covering the principles of biochemistry. (5 q.h.)

ES241 Water Supply and Sanitation - A complete study of water sources and treatment, for city, industrial and domestic use; materials on distribution systems and pumps with second half of the course dealing with sewage collection and purification. (5 q.h.)

ES243 Water Supply and Sanitation - This course is the study of sewage collection and treatment, including all the standard methods of treatment for purification, handling and disposal of sludges and industrial wastes. (4 q.h.)

INSTITUTION: OHIO STATE UNIVERSITY

PROGRAM: Chemical Engineering (air)

DEPARTMENT: Chemical Engineering

DEGREE: Bachelor of Science in Chemical Engineering (B.S)
Master of Science in Chemical Engineering (M.S.)
Doctor of Philosophy in Chemical Engineering (Ph.D.)

CONTACT: Dr. Thomas L. Sweeney
Department of Chemical Engineering
140 W. 19th Street
Ohio State University
Columbus, Ohio 43210
(614) 422-2727

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Courses in air pollution have been part of the Chemical Engineering curriculum at Ohio State University since 1965. Environmental engineering generally requires some background in chemistry, while chemical engineering, in its broadest sense, is environmental training and application. Undergraduates in this department receive initial instruction in physics, mathematics, and chemistry and in chemical engineering through coursework in heat, mass and momentum transport processes, thermodynamics, and reaction kinetics. According to the College of Engineering catalog:

> These fundamental concepts are then integrated into studies of chemical engineering operations and chemical processes. The last year of study is devoted largely to the research, development, and design aspects of chemical engineering, in which many concepts along with economics are brought together in the final design and optimization of a complete chemical process. In addition to the basic program, students elect courses in areas of specialization such as polymer engineering, process dynamics, optimization, petroleum engineering, nuclear engineering, rheology, pollution control, biomedical engineering, bioengineering, or other technical areas related to chemical engineering.

Undergraduate Chemical Engineering students are thus given tremendous flexibility in this program.

Graduate studies in the Department also provide students with a broad, though intensive, background in chemical engineering. Principal fields for specialization and research--primarily at the thesis stage--

include thermodynamics, kinetics, heat, mass and momentum transfer, unit operations, absorption, high polymers, rheology, air pollution control, waste treatment, petroleum, reservoir engineering, energy resources and control, chemical process research, nuclear chemical engineering, electrochemical engineering, plasma engineering, process optimization, and mathematical modeling and simulation.

Faculty consider the facilities for air-pollution research adequate but note that laboratory budgets are tightening. The Department receives considerable support from industry in the form of equipment, materials, and graduate fellowship monies. Current research centers on the removal of small particles from air streams.

The Department of Chemical Engineering also sponsors a series of short courses--each given several times throughout the year--sponsored under the auspices of the American Institute of Chemical Engineers. Topics include "Administrative Agencies and the Regulation of Technology" and "Understanding OSHA (Occupational Safety and Health Administration)."

PROGRAM REQUIREMENTS

Undergraduates must complete 220 quarter credit hours in order to obtain the B.S. degree; included in that number are 19 technical elective hours enabling the student to specialize in one of several technical areas (e.g., environmental engineering). The master's degree program "must include a series of advanced courses in the basic fields of thermodynamics, kinetics, and transport phenomena, and at least one advanced course in mathematics." The required thesis must take a minimum of nine quarter hours of research.

Doctoral candidates must complete 90 graduate credit hours after the master's degree or after the first 45 hours of graduate credit when the master's degree is not taken. Students must be proficient in undergraduate chemistry, including organic and physical; have at least 12 credit hours of advanced mathematics beyond differential equations; and have taken all advanced courses in the basic chemical engineering areas. Emphasis is placed on taking as much related work outside the department as possible.

CURRENT FACULTY, STUDENTS, GRADUATES

One full-time faculty member teaches the air-pollution-related courses in the Department of Chemical Engineering. Approximately 20-30 departmental undergraduates enroll in these courses. (Students from other programs take the "Legal Aspects of Engineering" course, too.) There are three M.S. students currently concentrating their studies in air pollution. Overall, 26 B.S., 10 M.S., and 4 Ph.D. Chemical Engineering diplomas are conferred annually. While the number of undergraduate degrees is increasing, the graduate student population is not growing substantially at present, primarily because industrial and government job offers entice many potential candidates away from the advanced degree programs. A heavy percentage of graduates take private sector jobs with the remaining students entering government at state and local levels.

All graduate students receive some form of financial support--many are on industrial fellowships. Those who want summer employment in professional capacities experience no difficulty in finding work.

PROGRAM PROJECTIONS

There are two to three open faculty lines at present in Chemical Engineering at Ohio State in which the Department would like to place environmentally oriented people, if good ones can be found. No curriculum revisions are forecast; and there is no impetus to create a more structured air pollution program of study for fear it will limit the flexibility of students seeking training in environmental engineering. Air pollution is viewed as an area that should be covered but not as a necessary prerequisite to training a bona-fied chemical engineer who someday may indeed handle an air quality problem. The current job market is excellent in Chemical Engineering.

In summary, the curriculum at Ohio State will, in all probability, remain one in which the student learns "principles," "concepts," and "broadly-applicable techniques" rather than "problem-oriented information" which can be learned on the job. As Dr. Thomas L. Sweeney, project contact in Chemical Engineering at O.S.U., noted in a June, 1973 paper presented at the Annual Conference of the American Society for Engineering Education:

> Environmental legislation has been the driving force for most of the actual hiring of engineers in environmentally related fields. We can best prepare our engineering students for these and other jobs by exposing them in at least a limited fashion to environmental concerns but all the while retaining the strengths of our traditional and intellectually demanding curricula.

COURSE DESCRIPTION

Chemical Engineering: 485 Inspection Trip - These trips will give some practical knowledge of the magnitude of modern chemical engineering operations from a selected variety of industry. (2 q.h.)

571 Air Pollution - Sources and dispersion of air pollutants, air pollution control, air quality criteria, emission standards and regulations. (3 q.h.)

671 Legal Aspects of Engineering - Basic legal concepts; the administrative process as exemplified by environmental regulation; patents, trade secrets; selected topics from the viewpoint of the engineer and scientist. (3 q.h.)

714 Environmental Pollution Abatement - Problems, philosophies, principles, and methods of pollution abatement in the total environment; quantitative approaches to waste management in air, water, and land systems. (5 q.h.)

771 Air Pollution - Sources of air pollutants, properties of small particles, chemistry of air pollution, dispersion and deposition of air pollutants, and air pollution control. (3 q.h.)

INSTITUTION: PORTLAND STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Engineering & Applied Science

DEGREE: Master of Science (M.S.) in Engineering

CONTACT: Dr. Frank P. Terraglio
Acting Head, Applied Science
Portland State University
Portland, Oregon 97207
(503) 229-4411

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering was instituted at Portland State University in 1966. Administered through the Department of Engineering and Applied Science, a major area of emphasis of this program is on air pollution.

Graduates of this program find employment within government and industry. Illustration of the types of occupations are: air pollution control chemist; air pollution control engineer; air pollution technician; and, air pollution control inspector.

PROGRAM REQUIREMENTS

In addition to the general university requirements, the Master of Science in environmental engineering requires completion of at least 27 credits in engineering and applied science, of which not less than 18 credits must be selected from 500-level courses excluding thesis. Nine credits, at least, must be selected from an area other than the candidate's major emphasis. A minimum of six credits of thesis is also required for the master's degree.

The student must also successfully complete an oral defense of the thesis and materials related to the candidates field of specialization.

CURRENT FACULTY, STUDENTS, GRADUATES

Current faculty associated with the master's program in environmental engineering totals two full-time teaching personnel. All are cost-centered.

Enrollment, at present, totals eight full-time students. Seven of these students are male and one is female. In addition, there are

44 male and six female part-time students who are not working for the master's degree. The average number of graduates each year is two.

PROGRAM PROJECTIONS

Significant growth is not anticipated for this program over the next few years. However, a new undergraduate degree, the Bachelor of Science in environmental engineering is being proposed. No time lines have been established, however.

COURSE DESCRIPTION (selected)

ASE 454, 455, 456 Electrical Energy Systems - Physical and engineering principles of power system analysis. (4 q.h. each)

ASE 469 Engineering Hydrology - Principles and applications of engineering hydrology associated with the planning and design of structures pertaining to water resources; precipitation, stream flow, flood control, reservoir yield, groundwater and evaporation. (3 q.h.)

ASE 471, 472, 473 Introduction to Air Conservation - Problems of air conservation, meteorological aspects, effects of air contaminants, control measures, air cleaning mechanisms, methods of atmospheric sampling and analysis. (3 q.h. each)

ASE 475 Industrial Air Pollution Control Techniques I - Principles, design, and application of air pollution control methods and equipment for industrial processes. (4 q.h.)

ASE 476 Industrial Air Pollution Control Techniques II - Principles, design, and application of air pollution control methods and equipment for industrial processes. (4 q.h.)

ASE 489 Transportation Systems: Planning and Design - A study of engineering problems associated with the planning and design of urban and inter-city transportation with emphasis on systems approach to problems definition and solution. (3 q.h.)

INSTITUTION: PRAIRIE STATE COMMUNITY COLLEGE

PROGRAM: Air, Water and Wastewater Technology

DEPARTMENT:

DEGREE: Associate of Applied Science (A.A.S.)

CONTACT: Dr. Glenn Schmitz
Prairie State Community College
P.O. Box 487
Chicago Heights, Illinois 60411
(312) 756-3110

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The two-year A.A.S. program prepares students for entry into the wastewater treatment, water treatment, and air pollution abatement fields in local government or industrial applications at the premanagement level.

A Certificate is awarded to students successfully completing a specific sequence of courses offered by the college. The program emphasizes those technical and skill areas required to provide employment skills. The student is prepared for entry into wastewater treatment, water treatment and air pollution abatement fields in local government or industry.

One full-time and two part-time faculty are involved in the program.

PROGRAM REQUIREMENTS

Sixty-five semester hours are required for the A.A.S. degree program; successful completion of 31 semester hours are required for the certificate program. Admission is open to all high school graduates. This policy has created some difficulty as many students have insufficient preparation to deal with program content.

CURRENT FACULTY, STUDENTS, GRADUATES

Lack of interest in the program may cause termination. Currently only five students are enrolled. Two students have graduated with an A.A.S.; one with a certificate. There has been no follow-up on the graduates.

COURSE DESCRIPTIONS (The following is a partial listing of courses)

Air, Water, and Wastewater Control Technology: AWT 101 Water and Wastewater Treatment Processes - A study of the types of water and wastewater treatment available with today's technology, including ion exchanges, softening, sedimentation, chlorination, ozonation, filtration, chemical precipitation, trickling filters, activated sludge processes, digestion, Imhoff tanks, primary treatment, and sludge handling. Field inspection trips to water and wastewater facilities. (3 s.h.)

AWT 102 Air Treatment Processes - The types of treatment for polluted air treatment facilities using today's technology. Emphasis is on the analysis and processes dealing with the measurement of air pollution and a study of controlling equipment. A field inspection trip of air treatment facilities is taken. (3 s.h.)

AWT 201 Water Distribution and Sewage Collection Systems - Deals with the basic hydraulics involved in layout of water distribution and sewage collection systems. General maintenance and repair procedures are covered. (3 s.h.)

AWT 202 Local Government, Funding, and Statutory Enforcement - The structure of American local government, with emphasis on its responsibility in controlling and treating water and air pollution. State and federal government water and air pollution abatement standards and administration, including their relation to local government and the private sector are introduced. Methods of financing private and public plant and system improvements are explored. (4 s.h.)

AWT 203 Laboratory Methods - Basic laboratory procedures, equipment and equipment maintenance. Test procedures and interpretations are demonstrated for all usual control tests generally in use in water and wastewater and air control field. (3 s.h.)

AWT 204 Industrial Wastes and Discharge - Identification and characterization of industrial wastes, both air and water, and special treatment procedures and problems related thereto. (3 s.h.)

AWT 205 Water Instrumentation - Study of existing instrumentation that is used for unit control and monitoring of air contaminants. (3 s.h.)

AWT 206 Air Instrumentation - Study of existing instrumentation that is used for unit control and monitoring of air contaminants. (3 s.h.)

Business: BUS 242 Personnel Management - Modern concepts of supervisory principles and practice are studied. Emphasis is on the human relations aspects of supervision, as well as on the functions of staffing, training, compensation.

INSTITUTION: PURDUE UNIVERSITY

PROGRAM: Environmental Sciences Option
DEPARTMENT: School of Science
DEGREE: Bachelor of Science (B.S.)

CONTACT: Dr. James Yackel, Associate Dean, School of Science
Purdue University
Mathematical Sciences Building
West Layfayette, Indiana 47907
(317) 494-8500

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The program began in 1973 and more than 70 courses are offered. It is interdisciplinary within the School of Science, although course work from many departments is accepted towards the environmental science option.

Options open to students include, but are not limited to: general environmental studies, air pollution, water pollution.

General environmental studies can be agriculturally oriented or science and engineering oriented. A minor in air pollution might be combined with a major in atmospheric sciences. A minor in water pollution might be combined with chemistry and geosciences. Each program is tailored to the student's professional orientation with the help of a faculty member or academic adviser.

PROGRAM REQUIREMENTS

Freshman admission requirements to the School of Science are:

1) high school graduate with 16 units: English (6), History or Social Studies (2), Algebra (3), Geometry (2), Trigonometry (1), Laboratory Science (2);
2) Indiana residents must be from the upper half of their high school graduating class and have SAT scores in the upper half of national norms;

   Out-of-state must be in the upper third of their high school graduating class and have SAT scores in the upper third of national norms;

3) SAT scores and College Entrance Examination Board achievement tests in English, Mathematics, Chemistry (used for academic placement);

4) information provided by high school counselor.

A B.S. in the General Science program requires 124 credit hours:

general scientific studies	35 - 40 hours
major science concentration	12 - 23 hours
additional scientific studies	4 - 10 hours
minor concentration	18 hours
general humanistic studies	27 - 28 hours
free electives	5 - 28 hours

In preparation for the environmental science minor,Ecology: BIOL 585-586, Programming I: CS 220, Experimental Statistics I: STAT 501, and one or more of 11 specified courses from Economics, Political Science or Sociology should be taken.

CURRENT FACULTY, STUDENTS, GRADUATES

There is no special faculty for the environmental studies options. Courses are offered through the regular academic departments of the School of Science and the faculty there numbers 280. Research has been done with Lake Michigan shore erosions, northern Indiana dunes, population ecology and field ecology.

Presently there are 15 enrolled in the program; 4 graduate yearly. Fifty percent of the student receive employment in government, 25 percent in industry and 25 percent in other areas.

About 200 undergraduate students are assisted financially through teaching assistantships, research assistantships or an hourly wage. A co-operative program is also available. Students complete two years of school and then, while working on campus or during the summer, take four credit hours a semester. Obtaining a degree in this manner takes four and one-half years. In the past, arrangements have been made with government labs (i.e., Argonne) to provide these opportunities.

PROGRAM PROJECTIONS

The department sees no change in the long range goals and objectives of the program. The various options are seen as continuing to be chosen by a small number of students. The impetus for change will need to come from a small nucleus of faculty.

ADDITIONAL INFORMATION

The School of Science has four departmental libraries: Chemistry, Geosciences, Mathematical Sciences, and Physics. The Department of Biological Sciences is served by the Life Science Library.

COURSE DESCRIPTION (a partial listing; others available from agriculture, entomology, forestry, horticulture, civil, mechanical, electrical engineering)

Undergraduate:

Bio. Sciences: 285 Environmental Biology - Interactions of the biotic and abiotic components of natural environments. Ecological principles and phenomena associated with populations, communities, and ecosystems. Natural selection and other aspects of evolution. Principles of conservation. (3 s.h.)

Computer Sciences: 220 Programming I - Introduction to the intuitive notion of an algorithm; representation of algorithms in narrative form as flow charts and as computer programs; general structure of computers; computer experience using a procedure-oriented language in programming algorithms such as those used in elementary numerical calculations, sorting, simulation of a random process and symbol manipulation; definition and use of functions, subroutines and iterative procedures; survey of a variety of significant uses of computers. (3 s.h.)

Physics: 200 Our Physical Environment - Selected topics in physics which relate to man's environment. Particular emphasis will be placed on energy resources, relationships between medicine and physics, and modern applications of discoveries in physics. (3 s.h.)

Undergraduate/Graduate courses:

Atmospheric Sciences: 539 Air Pollution Meteorology - Sources of air pollution and variations of pollutants with space and time. Concepts of hydrostatic stability and turbulent flow in the atmospheric boundary layer, with application to urban diffusion models. Requirements and limitations of air pollution measurements, a total monitoring program and analysis of data. The role of macroscale circulation systems and large scale weather prediction in air pollution potential forecasting. Principles of radiation transfer and cloud physics applicable to potential climate modification by air pollutants. (3 s.h.)

Biological Sciences: 585 Ecology - Examination of ecological principles derived from study of patterns of distribution and abundance in plants and animals; structure and function in populations, communities, and ecosystems; role of population genetics, adaptation, and evolutionary theory in ecology. (2 s.h.)

586 Laboratory in Ecology - Laboratory and field studies designed to demonstrate ecological principles; sampling

586 (Cont'd) - methods and problems of experimental design; application of selected statistical methods in the analysis and interpretation of data; simulation models in population genetics, population ecology and ecosystem function. (2 s.h.)

Statistics: 501 Experimental Statistics I - Fundamental concepts and methods of statistics for students interested in the analysis of experimental data. Subjects include descriptive statistics, basic probability theory, normal distribution, tests of hypotheses and confidence intervals for normal and Bernoulli populations, contingency tables, tests of goodness-of-fit; linear regression and nonparametric tests. (3 s.h.)

INSTITUTION: RENSSELAER POLYTECHNIC INSTITUTE

PROGRAM: Environmental Engineering

DEPARTMENT: Chemical and Environmental Engineering

DEGREE: Bachelor of Science (B.S.)   Doctor of Philosophy (Ph.D.)
Master of Engineering (M.E.)
Master of Science (M.S.)
Doctor of Engineering (D.E.)

CONTACT: Dr. David Hansen, Chairman
Dr. William W. Shuster
Environmental Engineering Program
Chemical and Environmental Engineering Dept.
Rensselaer Polytechnic Institute
Troy, New York 12181
(518) 270-6377

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Chemical and environmental engineering are combined as disciplines at the Rensselaer Polytechnic Institute into the Chemical and Environmental Engineering Department. Rensselaer is one of the few institutions of higher education in the United States which offers a baccalaureate degree in environmental engineering. The Environmental Engineering Program builds on a broad base of studies in chemistry, life science, and engineering science in a three-year pre-engineering portion of the program, and during the senior year students receive specialized study in environmental engineering. The senior year consists of a sequence of courses designed around unit processes and integrated laboratory design courses. Employment for graduates of the program may be found in industry, consulting, government, research agencies and teaching.

On completion of the three-year pre-engineering curriculum, an undergraduate may continue to the two-year professional program leading to the Master of Engineering degree. Students electing the professional program may elect any of four options emphasizing water resources, solid waste, air pollution or radiological health. The Master of Engineering degree is awarded on completion of specified programs which are accredited by the Engineers' Council for Professional Development. The Master of Science degree is awarded on completion of a program which is individually arranged and appropriate to the major field. The Doctor of Engineering and Doctor of Philosophy degree programs are also arranged individually and emphasis is placed on advanced study in a specialty, with a major focus on thesis work. At the graduate level, students are encouraged to take cross-disciplinary studies using other Rensselaer courses outside of the department.

The department utilizes extensive research and instructional laboratories with a broad range of process and analytical instrumentation. Water resources laboratories are located at the Fresh Water Institute at Lake George. Current research is conducted in the study of water resources and its subtopics of treatment technology, environmental monitoring, and modelling of water ecosystems. Other environmental engineering research efforts are being directed in the area of air resources, solid wastes, radiological health, and other related areas. Some interdepartmental research is also being conducted with other departments in the areas of environmental acoustics, radiological health, water resources, and bioengineering.

PROGRAM REQUIREMENTS

Students seeking admission at the same level to the baccalaureate program must first be admitted to the university and satisfy the pre-engineering requirements. Junior college transfers can enter the program at the third year as long as their educational backgrounds are equivalent to what is offered during the first two years at Rensselaer. Department officials stated that prospective students should have taken four years of high school mathematics and science and have graduated in the top 10 percent of their class.

The Master of Engineering program, administered by the Professional School is EPCD-accredited, and graduates of other schools may be admitted with advanced standing and may normally complete the degree program in one year, if their baccalaureate engineering degrees are accredited. Master of Engineering candidates must: (1) be admitted to the Professional School of Engineering; (2) fulfull the general requirements; (3) complete the prescribed curriculum in the Professional School satisfactorily, and (4) complete an engineering project.

A total of 133 hours is required for completion of the Bachelor of Science degree in Environmental Engineering. In addition to the three-year pre-engineering program totaling 102 hours, the two-year Master of Engineering program requires completion of an additional sixty-one hours. The doctorate requires completing ninety credits beyond the bachelor's degree and a doctoral thesis or engineering project.

Although Rensselaer has established an Industrial Traineeship Plan, there is no sponsorship under this plan for environmental engineering students. The Chemical and Environmental Engineering Department does participate in a cooperative education program with industry. In the cooperative plan programs, students alternate periods of employment with periods of on-campus education; however, there is no financial support from the sponsor directly to the student's educational program.

Normal federal financial aid programs are available to students at the undergraduate level. At the graduate level, the only source of funding for students is research contracts. Training grants have almost disappeared and one U.S. Environmental Protection Agency fellowship is being funded. In addition, one industrial fellowship is available.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten faculty members are currently involved with teaching and research activities associated with the Environmental Engineering program. Many faculty members are involved in both portions of department's program. It is estimated that there are four and one-half full-time equivalent faculty members each involved with teaching and research.

At the undergraduate level during the pre-professional program, students are not identified as being environmental engineering oriented. While there are about twenty seniors in environmental engineering, this is out of a total of about 800 senior undergraduates in the engineering school. There are no part-time undergraduate environmental engineering students enrolled.

Fifty-four graduate students have chosen to specialize in environmental engineering at Rensselaer. Of these, forty are full-time students; two are female. There are fourteen part-time students taking graduate environmental engineering programs, and of these, one is female. It is estimated that 3½ percent of the undergraduate and 5 percent of the graduate students in the School of Engineering elect environmental engineering.

Within the last five years, an average of twenty-five undergraduates received baccalaureate degrees in environmental engineering at Rensselaer. At the graduate level, within the last three years on an average, twenty students have received master's degrees and three have received doctorates.

With the decline of training grants from the U.S. EPA, Rennselaer has felt less tied to offering specific curriculum specializations to environmental engineering students. Emphasis at the undergraduate level has been placed on providing students with a solid fundamental environmental engineering background. Master's students are required to complete a six-credit thesis, and the topic is usually in the student's chosen area of specialization. Approximately one-third of the master's program includes required fundamental courses. About one-half of the environmental engineering students elect to specialize in the water resources area. One-fourth elect the air option, and one-fourth select the other two remaining areas of concentrations.

Due to increasing governmental cutbacks in hiring, most of the environmental engineering graduates have found employment within private industry (mainly consulting firms.) There are a consistent number of graduates employed by industry involved in the design and manufacture of equipment for environmental control. Other graduates find employment with research groups and within academia.

PROGRAM PROJECTIONS

Although the Rensselaer environmental engineering program is not expected to significantly change in size and emphasis over the next five years, research programs may be expanded. Two additional environmental engineers with air or water resources backgrounds may be recruited for an expanded research program. An environmental science degree may be developed at Rensselaer within the School of Science as the Biology Department is active in environmental studies.

Rensselaer officials expect enrollment in environmental engineering to begin to level out, and keep pace with population trends. More emphasis in the next few years is expected to be in the application of chemical processing in the pollution control areas. The curtailment of the EPA training grant program has had a serious effect on the number of students entering environmental engineering graduate programs at Rensselaer. Departmental officials feel that there is a need to reinstate the EPA training grant program.

A main attraction of the Rensselaer environmental engineering program is the fact that it is one of the strongest undergraduate programs in environmental engineering in the United States. The graduate program is also considered to be one of the premier environmental engineering programs in the nation.

COURSE DESCRIPTION

32.405 Unit Operations in Environmental Engineering - A study of the physical processes, termed unit operations, that are common to air, water, and land pollution control systems. (3 s.h.)

32.406 Unit Processes in Environmental Engineering - The study of several physical-chemical and biological processes encountered in environmental pollution control and water supply. (3 s.h.)

32.407 Environmental Acoustics - A study of man's total sonic environment. (3 s.h.)

32.409 Water and Wastewater Engineering - The topics studies are: estimates of water demands, water supply sources, water quality criteria, transmission and distribution of water, water pumping and storage systems, rural water supply and other topics. (3 s.h.)

32.415, 32.416 Environmental Engineering Laboratory I & II- Experiments are performed in the areas of water, wastewater, solid wastes and air pollution. (2 s.h. each)

32.423 Air Pollution: Sources and Effluents - Fundamental aspects of air pollution with emphasis on emissions from major stationary and mobile sources (automobiles). (3 s.h.)

32.431 Solid Waste Engineering - Classification and characteristics of solid wastes, the need for and rating of solid waste management systems, design of municipal refuse collection and transfer systems, methods and costs of solid waste disposal, and other subjects. (3 s.h.)

32.442 Industrial Waste Treatment and Disposal - Physical, chemical and biological characteristics of industrial wastes. (3 s.h.)

Graduate Courses:

32.601 Public Health I - Occurrence and control of communicable diseases; principles of epidemiology and biostatistics and their application, emphasizing the relationship with environmental factors; air pollution sources and health effects. (2 s.h.)

32.602 Public Health II - International, federal, state and county health organizations, responsibilities, and functions; water quality management and public water supplies; solid wastes management; radiological health controls; air resources controls and management. (2 s.h.)

32.603 Chemistry for Environmental Engineers - The weekly 3-hour laboratory emphasizes analytical measurements using instrumental techniques; most experiments are drawn from the water and wastewater field, a few from air pollution. (3 s.h.)

32.611 Water Resources - Elements of meteorology and hydrology. Precipitation, runoff, stream flow, watershed losses, unit hydrograph, and groundwater problems. (3 s.h.)

32.612 Physical Chemical Waste Treatment - The application of theoretical principles and pilot plant data to the design and operation of advanced waste treatment systems. (3 s.h.)

32.614 Stream Pollution Control - The economic aspects of water pollution; health aspects of bacterial pollution. (3 s.h.)

32.616 Environmental Impact Analysis - Studies related to the evaluation of the impacts of major actions by state and federal agencies on the quality of human environment. (3 s.h.)

32.620 Atmospheric Chemistry - The course presents important thermodynamic and kinetic aspects of reactions in the atmospheric layer. (3 s.h.)

32.622 Air Pollution Meteorology - Investigation of atmospheric processes of particular importance in dealing with the environmental problems of air pollution. (3 s.h.)

32.624 Air Pollution Control - The major approaches to air pollution control are discussed from three different viewpoints. (3 s.h.)

32.634 Environmental Radiation Safety Controls - Consideration and control of the health hazards peculiar to the atomic industry. (4 s.h.)

INSTITUTION: RUTGERS - STATE UNIVERSITY OF NEW JERSEY

PROGRAM: Environmental Science
DEPARTMENT: Environmental Science
DEGREE: Master of Science (M.S.); Doctor of Philosophy (Ph.D.)

CONTACT: Professor A. Joel Kaplovsky
Director of Graduate Programs in Environmental Science
401 Georges Road Laboratories, Cook Campus
Rutgers - State University of New Jersey
New Brunswick, New Jersey 08903
(201) 932-9571

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Science at Rutgers has long-standing multidisciplinary graduate teaching and research programs since inception in 1920. This problem-oriented program deals primarily with technological solutions to the contamination of our environment from particulate matter, gases, vapors, liquids, and undesirable organisms. Emphasis is placed on the application of the physical, chemical, and biological sciences toward this end. The following areas of specialization are offered: air resources; aquatic biology; aquatic chemistry; chemistry and physics of aerosol and hydrosol systems; environmental chemistry; environmental microbiology; water and wastewater treatment (wastewater is largest area of emphasis); and water resources.

The Environmental Science Program at Rutgers is the oldest of its kind in the United States, and deals with chemical and biological application to the solution of environmental problems. A specialized research group, Rutgers graduates from the Environmental Science Department are qualified for positions in the environmental field where expertise is needed for solutions of problems in which the air, water, solids, and pollution interact. Trained as multidisciplinary scientists, graduates may obtain positions as researchers and as high school and college instructors. They may also find positions within private industry working on waste problems as either industry employers or as consultants. Positions within government may be found in administration, enforcement, research, inspection, and control. Positions for the program's graduates exist at treatment facilities in the capacity of supervisor, director, analyst, technician, and operator.

The department's Environmental Science Laboratory is staffed with bench-oriented, problem-solving scientists in the pollution field.

Facilities are available for the solution of problems ranging from the most simple and practical to those requiring sophisticated analytical capabilities.

Seminars and a large non-degree short course program are conducted by Departmental faculty. Forty percent of the short course teaching load is in the areas of air, wastewater, water supply, and solid wastes. An environmental training center has been developed and one short course consists of seven days a week for air, wastewater, solid wastes and water supply training.

PROGRAM REQUIREMENTS

In order to enter the Environmental Science Program, prospective students must have a strong science-based background including chemistry, physics, biology, mathematics. No students without chemistry background will be accepted into this program. Verbal and aptitude scores from the Graduate Record Examination are required and students must have a grade point average of 2.5 on a one point (high) scale.

In order to obtain the Master of Science degree, 30 credits of required course work (the research M.S. requires 24 credits plus a 6 credit thesis), which represents 50 percent of the selected program of study, must be fulfilled. Research is required to be in the major field of study, and is a twelve month program which requires an advisor. A candidate for the Doctor of Philosophy degree must normally spend not less than one academic year or two consecutive terms, excluding the summer session, as a full-time student in residence. A foreign language requirement for the doctorate is stipulated, and can be fultilled either by examination or by course work (without credit), as approved by the program faculty. Forty-eight hours of course work plus twenty-four hours of research are required for fulfillment of the doctorate.

Research funding is available from the U.S. EPA, the National Science Foundation, the National Institute of Health, the Army Corps of Engineers, and the Department of Energy. The New Jersey Department of Environmental Protection and private industry also fund research concerning waste problems associated with air, water and solids pollution.

A variety of financial aid is available to graduate students and include research contracts, training contracts, industrial fellowships, teaching assistantships, coadjuncts and loans. The Danforth, Woodrow Wilson and Ford foundations offer fellowship programs for graduate students. The National Science Foundation offers graduate fellowships for beginning graduate students. Various publicity and privately sponsored fellowships include stipends ranging from $2,000 to over $5,000 a year and usually cover remission of normal tuition charges, including six summer credits. Teaching and graduate assistantships provide salaries beginning at about $3,969 a year with remission of tuition charges for both the fall and spring terms, plus an additional remission allowance (6 credits) for optional summer study. Assistants are usually required to spend up to fifteen hours per week on their jobs, whether in teaching or research.

CURRENT FACULTY, STUDENTS, GRADUATES

Twenty faculty members contribute to the teaching and research conducted by the Environmental Science Department. Only twelve faculty are involved in full-time teaching activities and fourteen staff teach the Department's courses. Fourteen staff members are involved in research activities.

There are currently 130 students enrolled in the Environmental Science Program and 70 are full-time students. Ninety of the students are male and forty are female (there are no female part-time students). Officials estimate that approximately 40 students annually receive degrees, on the average. Enrollment appears to be steadily increasing in the Environmental Science Department over the past several years.

All those graduating from the Department find employment directly related to their training. Approximately 35 percent of recent graduates find private sector industrial and consulting positions. Another fifteen percent obtain teaching positions within academia and the remaining 50 percent find public sector jobs. Many employers call the Department seeking to employ graduates from the program and this is considered by program officials to be an excellent method of finding employment.

PROGRAM PROJECTIONS

Because of recent rising enrollment trends additional faculty in the chemical and toxicity specialty areas may be recruited within the next five to ten years. Expansion of staff often takes a great deal of time because of the requirement of justifying growth. Program officials find that because of the complexities and work to be performed in this field, the present staff could be easily doubled in size.

The Environmental Science staff has considered developing Master's degree programs in environmental health and occupational health (industrial hygiene). Because the Rutgers program currently is stronger in the pollution sciences than others, wastewater aspects relating to health problems would be emphasized. Recent research has indicated that environmental and occupational health fields have been largely overlooked. Fields such as toxicology and epidemiology are needed to study the effects of low level pollution that is concentrated in the environment because they impact on man. Rutgers is uniquely situated to study such effects because eleven percent of the chemical industry in the nation is located in New Jersey. There is an unlimited potential for expansion in both teaching and research in the chemical and toxicity fields. To adequately begin research in this area, the Rutgers program would have to double its present staff and all present programs should be expanded in a sophisticated direction.

COURSE DESCRIPTION

(the following is a partial listing of courses offered)

Graduate courses 16:375:

501 Waste Treatment I: Sewage Treatment - Physical, chemical and biochemical processes utilized to treat municipal wastewaters. (3 s.h.)

502 Stream Sanitation - Principles of biological stabilization of pollution materials in streams; factors influencing atmosphere reaeration; changes in biological populations in polluted waters. (3 s.h.)

503 Analytical Techniques in Environmental Chemistry - Theory and techniques of analytical procedures applicable to research in environmental science. (3 s.h.)

504 Waste Treatment II: Water Treatment - Chemical, physical, and biological factors affecting development of water supplies; water quality; municipal and industrial water treatment processes. (3 s.h.)

508 Application of Principles to Treatment Problems - Application of fundamental principles concerned in water purification and liquid and waste treatment processes to design and operation problems. (3 s.h.)

510 Pollution Microbiology - Bacteria as indicators of sanitary conditions; liquid and solid waste treatment processes. (3 s.h.)

517, 518 Principles of Environmental Science - Principles and interaction associated with air environment, water environment, and environmental health. (3 s.h. each semester)

524 Source Control of Atmospheric Pollution - Principles, operation, performance, and application of methods and devices to control aerosol and gaseous emissions. (2 s.h.)

525 Principles of Solid Waste Management and Treatment - Solid waste problems in the municipal, industrial, and agricultural areas. (3 s.h.)

526 Limnology of Urban and Suburban Waters - Study of waters stressed by population, development, wastes. (3 s.h.)

INSTITUTION: SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

PROGRAM: Environmental Technology

DEPARTMENT: Environmental Technology

DEGREE: Associate in Science (A.S.)

CONTACT: John T. Donohue, Chairman
Division of Engineering Technologies
Springfield Technical Community College
Armory Square
Springfield, Massachusetts 01105
(413) 781-6470

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This two-year Environmental Technology Program integrates two technical environmental options: Quality Technology, and Wastewater Treatment Technology. Formerly, these two options had separate curriculum structures but now are offered in one curriculum. The orientation is toward environmental engineering with the goal of training students to become para-professionals to assist an engineer. Their functions would include detecting and measuring pollution, installing control facilities, and operating purification facilities. It is anticipated that graduates would qualify for positions in industrial facilities, governmental agencies, municipal engineering offices, engineering firms, waste treatment plants and manufacturers representatives. This career-orientated program has not been designed to enable a student to transfer to a four-year college program. Springfield Technical Community College is an accredited member of the New England Association of Schools and Colleges.

The Department of Environmental Technology offers extensive facilities to assist students in receiving "hands-on" instruction. The program utilizes a complete chemical laboratory, a small model of an activated sludge filtration system, and air and water sampling equipment. Water samples are also picked up by the department from the Springfield waste treatment facility for analysis by students in the laboratory. In addition the program emphasizes its summer practicum between the first and second year in which students work forty hours a week for five weeks at treatment facilities (12 to 15) located within a 75 mile radius of the college.

PROGRAM REQUIREMENTS

In order to be considered for admission into the Environmental Technology Programs, prospective students must have had one year of chemistry and two years of algebra or its equivalent. Structured into the four semester curriculum (including the summer practicum) are sixty-eight credit hours of requirements. Included are courses covering the topics of process problems, environmental microbiology, technical report writing, treatment plant operations, industrial health and safety, water sample, analysis and control processes, systems maintenance, and air sample, analysis and control processes.

Most of the forms of financial aid available to students consist of the Basic Educational Opportunity Grant Program and Work-Study. Limited amounts are available from other funding sources.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time faculty members contribute to the Environmental Control Technology Program of instruction. Currently (fall, 1977) the program has an enrollment consisting of twenty-six full-time male students, and approximately 10 students graduate annually on an average. Enrollment appears to be slowly increasing over the past few years.

Although this program is designed to be terminal, about eight to ten percent of the graduates continue on for higher education, although most find employment as waste treatment plant operators. For example, some of the program's graduates have changed their original career objectives midway through completion of the program and are enrolled in a general environmental science program (bachelor's) offered by the University of Maine. Although the college assists students in their employment search through its placement office, students often have more success securing jobs through participation in the summer practicum and responding to employers inquiries made to the department. Program officials estimate that 95% of the graduates obtain employment in their field and 5% in a related field. Although most (80%) find government jobs, some students (20%) find jobs in the private sector, mostly in paper mills.

PROGRAM PROJECTIONS

The Environmental Technology Department is not anticipating hiring additional faculty members over the next five years as the program can accomodate more students with present staff. The program is flexible enough in orientation to be able to adapt to changing needs but current emphasis is on the development of the program's current resources.

The need to train wastewater treatment plant operators is expected to continue to increase although the need will begin to level off once the plants are built. However, department contacts do not anticipate that they are anywhere near a saturation point in the near future.

COURSE DESCRIPTION

6183 Wastewater Sample and Process - An investigation of the chemistry of domestic and industrial liquid wastes, their effects upon wastewater treatment plants and processes and the test procedures and techniques required for treatment plant operation. (3 s.h.)

6186 Environmental Studies - An introduction to environmental pollution, its effect on man and other living things and the basic principles of sanitation, treatment and control. (3 s.h.)

6190 Systems Operations and Maintenance - A study of wastewater treatment plant equipment with emphasis on diagnosis and repair and preventive maintenance programs. (3 s.h.)

6192 Treatment Plant Unit Operations I - An investigation of the physical and chemical processes utilized in the treatment of liquid wastes. (3 s.h.)

6197 Air and Water Quality Control Processes - A study of the processes utilized to reduce or eliminate pollution of the atmosphere. (3 s.h.)

6200 Air and Water Sampling and Analysis - An investigation of the equipment and techniques used in atmospheric sampling and of the instruments used to analyze the samples. (3 s.h.)

6201 Industrial Health and Safety - An investigation of the procedures and attitudes required so that man may safely work in the vicinity of industrial processes and equipment. (3 s.h.)

6234 Basic Instrumentation - A study of electrical, electronic and pneumatic basic and operating principles as applied to instrumentation used for the measurement and control of process variables. (3 s.h.)

6328 Treatment Plant Unit Operations II - An investigation of the physical and chemical processes utilized in the treatment of liquid wastes. (3 s.h.)

INSTITUTION: STEVENS INSTITUTE OF TECHNOLOGY

PROGRAM: Air Pollution Control Engineering (Mini-Graduate)

DEPARTMENT: Mechanical Engineering

DEGREE: Certificate of Special Study

CONTACT:
Dr. Fernando Sisto, Jr., Head
Department of Mechanical Engineering
Stevens Institute of Technology
Castle Point Station
Hoboken, New Jersey 07030
(201) 792-2700

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This mini-graduate program in air pollution control engineering originated in January, 1976, for the purpose of educating working professionals at the post-graduate level. It meets the needs of employed engineers who are seeking advanced professional training or are changing their fields of interest.

Four graduate level courses of an applied nature make up the program, and the certificate in awarded only after completion of all four courses. These courses may also be taken in fulfilling the requirements of the Master of Engineering or Master of Science Degree. For the convenience of working professionals, classes are offered in the evenings.

An air sampling laboratory is located on campus and is used in support of this program.

PROGRAM REQUIREMENTS

Entrance to the program requires that a student must meet the admission requirements for graduate study in the Department of Mechanical Engineering. The prerequisite for this is generally a bachelor's degree in engineering from an accredited college or university.

Completion of ten credits of study are required for the certificate. There are four courses of two and one half credits each which must be taken. No electives are permitted. Two of the courses are offered in the fall semester and the remainder in the spring. No additional requirements exist for the certificate.

The Master of Engineering or Science degree requires the completions of thirty graduate credits. The ten credits in the certificate program may be applied towards the Master's requirements. The student would then receive both the certificate and the degree.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently two full-time faculty members participating in the air pollution program and they divide time between teaching and research. Funding for environmental research has been available from the U.S. Public Health Service and the National Science Foundation.

Students for the program are recruited primarily from industries and consulting firms working in air pollution control. This program also attracts some students from the Mechanical Engineering Department because of their familiarity with it. Most students receive some form of financial assistance. The employed students normally have tuition paid by their employers.

This program was just initiated in 1976 and there have been no graduates as yet.

PROGRAM PROJECTIONS

No expansion in this particular program is anticipated but officials are considering the possibility of offering a certificate program in noise pollution.

COURSE DESCRIPTION

ME 140 Origins and Analyses of Air Pollutants - Atmospheric and source emission testing of air pollutants; laboratory and field work involving sampling and testing for the concentrations of particulates, nitrogen oxides, hydrocarbons, carbon monoxide and sulfur dioxide in the atmosphere and in chimneys; and other topics. (2.5 s.h.)

ME 141 Air Pollution Control - Control of pollutant emissions from vehicles and from stationary industrial sources; particulates, nitrogen oxides, carbon monoxide, hydrocarbons, sulfur dioxide and others; cyclone separators, electrostatic precipitators, baghouse collectors, and others. (2.5 s.h.)

ME 190 Environmental Law for Practicing Engineers - Review of laws regarding air, water and noise pollution. Role of engineer representing a company or the public before governmental agencies. Permit system, implementation plans, and other legal sanction. Site studies and environmental impact statements. (2.5 s.h.)

ME 277 Environmental Aerodynamics - Basic aerodynamic considerations: lift and drag forces; wind loading on buildings and chimneys; elements of metoerology; thermal pollution of the environment: cooling water discharge into lakes, rivers and oceans. (2.5 s.h.)

INSTITUTION: SUMTER AREA TECHNICAL COLLEGE

PROGRAM: Environmental Engineering Technology
DEPARTMENT: Environmental Engineering
DEGREE: Associate in Engineering Technology

CONTACT: Mr. Robert C. Chen
Head of Environmental Engineering
Technical Division
Sumter Area Technical College
506 Guignard Drive
Sumter, South Carolina 29150
(803) 773-9371

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This two-year program in environmental engineering is accredited by the Engineers' Council for Professional Development (ECPD), and was implemented in 1968. Courses currently focus on potable water, wastewater, air pollution, and solid waste disposal; however, the environmental fields of pesticides, noise, and radiation receive limited coverage. Inquiries concerning this program have been received from institutions all over the world.

Graduates of this program should have the knowledge of principles and laboratory procedures necessary to perform tests on liquid and solid wastes, water, and foods to determine their suitability for release into the environment. They are considered qualified to enter such positions as industrial waste technician, municipal water and sewage treatment plant operator, and water pollution control and sanitary technician. Graduates may also find employment as technical sales and service personnel for equipment and chemical companies, and as engineering technicians with governmental and private organizations. Officials believe that in many respects, graduates of this program serve industries and municipalities better than graduates of four-year programs.

The faculty of this program have participated in offering NPDES training to operators of wastewater treatment plants, in cooperation with state and federal agencies, and have carried out non-sponsored training courses for plant operators. The ECPD has rated the laboratory facilities available to the program's students and faculty as "exceptional".

PROGRAM REQUIREMENTS

High school graduation or the equivalent is required for entrance into the college. Students deficient in crucial areas, as determined by SAT or ACT scores, are referred to the school's learning laboratory for special instruction.

The environmental engineering technology program consists of 105 quarter hours of credit. Twenty-four of these credits are required in general education, while forty-three are in the major field. An additional twenty-three hours are required in the areas of biology, chemistry, engineering, and analytical geometry and calculus. Fifteen hours of electives may be chosen from a selection of eight courses in the areas of civil engineering, drafting, mathematics and physics.

Several field trips are included in each student's curriculum. Seniors must carry out research-related projects under the supervision of an instructor. The environmental engineering faculty is seeking to cooperate with the City of Sumter in offering an internship program. As anticipated, each student will spend one quarter (summer quarter) working for the city in an environmental field for pay.

CURRENT FACULTY, STUDENTS, GRADUATES

Two full-time faculty members are responsible for teaching the environmental engineering courses, and twenty-eight students are currently enrolled in the program. Only 40 to 50 percent of each freshman class typically reaches graduation in this field because of the program's difficulty.

The number of annual graduates has decreased since the program's inception. This fact is attributed in part to the trend for students not to be willing to invest full effort into the curriculum, and to the low pay scales within the wastewater treatment industry. Laboratory classes are of necessity scheduled during the afternoon, and students are often unable to hold jobs while in this curriculum.

The faculty attempts to keep track of graduates with follow-up letters. The response rate, however, is quite low. From available information, it appears that nearly all graduates have been able to secure employment in the environmental field, mainly in water and wastewater treatment. An estimated 20 percent are now employed with industries, while most of the remainder are with municipalities. Several are employed with state agencies, and a number have opted to continue their schooling.

PROGRAM PROJECTIONS

Officials of the environmental engineering technology program would like to expand upon the areas of radiation control and pesticides in the curriculum, and add the area of energy. If plans are carried through, students in the environmental engineering curriculum would be able to concentrate in potable water, wastewater, air pollution control, radiation control, pesticides, noise control, solid waste, or energy. All students would continue to receive broad environmental training, and would be qualified for a variety of positions.

Because many students are not willing to invest two years into this difficult curriculum, officials are also anticipating developing a one-year program to train environmental control assistants in the areas of water and wastewater plant operations, water and wastewater laboratory, solid waste disposal and/or for field work in state and local health departments. An initial enrollment of twelve to fifteen students is expected, based upon preliminary industrial surveys, with a gradual increase to twenty. A diploma would be awarded upon completion of this program and students would be able to transfer to the two-year environmental program.

In order to implement this program, additional faculty would be required, one for the fields of energy and radiation control, and one for the one-year water and wastewater program. To expand upon the field of pesticides, the department will cooperate with the Agricultural Department of the college.

ADDITIONAL INFORMATION

Instructors of this program have expressed that adequate curriculum materials in the environmental field are not available for two-year programs; most of the materials that are available are overly technical for this level.

COURSE DESCRIPTION

EVT 100 Introduction to Environmental Technology - Major sources of pollution and methods of control. Topics include water pollution, solid waste, air pollution and noise abatement. Field trips to wastewater plants. (3 q.h.)

EVT 212 Water Supply Engineering - The planning of water systems. Population predictions, water, water sources, design of collection and distribution systems, water quality criteria, principles of water purification. (4 q.h.)

EVT 214 Elements of Sanitation - Disease transmission and control; epidemiology; rural water supply and waste disposal; insect and rodent control; solid waste collection and disposal; milk and food sanitation; swimming pool sanitation; industrial hygiene and toxicology; administration of public health. (3 q.h.)

EVT 215 Environmental Chemical Analysis I - The study of water chemistry. Principles and laboratory techniques for control tests of water purification and interpretation of analysis results. (4 q.h.)

EVT 221 Air Pollution Control - Principles of air pollutants control; their classification, dispersion, and control methods. (3 q.h.)

EVT 223 Solid Waste Disposal - The problems involved with solid waste and solid waste disposal. Sanitary landfill and incineration, with emphasis on design and operation. Future solid waste problems and processing. (3 q.h.)

EVT 224 Wastewater Engineering - The principles of wastewater collection and treatment systems, the design of sanitary and storm sewers, and the chemical, physical, and biological characteristics of wastewater and the treatment principle. (4 q.h.)

EVT 225 Environmental Chemical Analysis II - The principles and laboratory techniques for control tests of wastewater treatment such as BOD, COD tests, laboratory formulation of the BOD and NOD curve, determination of K value of BOD reaction, etc. (4 q.h.)

EVT 226 Biological Environmental Engineering - The fundamental microbiology and biochemistry of the microorganisms of importance to the sanitary engineer and interpretation of their relationship to the various designs which interest the sanitary engineer. Designs include trickling filter, activated sludge, and oxidation pond methods. (4 q.h.)

EVT 231 Stream Quality Control - The study of stream pollution and its control. Topics include principles and control of organic pollution and self-purification, mathematical formulation of oxygen sag curve, nutritional pollution and entrophication, microbial pollution, persistent chemical pollution, inorganic salts and thermal pollution. (3 q.h.)

EVT 232 Industrial Waste - Principles of industrial waste pollution and treatability study. (4 q.h.)

EVT 233 Water Quality Engineering - Principles and applications of chemical, physical, and biological methods of water quality control. Emphasis on newly developed treatment processes such as nitrification and dentrification, absorption, filtration, ion-exchange, membrane processes, chemical oxidation, disinfection, corrosion control and sludge treatment. A report required on some aspect of the treatment process. (4 q.h.)

INSTITUTION: SYRACUSE UNIVERSITY

PROGRAM: Chemical Engineering

DEPARTMENT: Chemical Engineering and Materials Science

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. James A. Luker
Dean, College of Engineering
Syracuse University
Syracuse, New York 13210
(315) 423-4341

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The chemical engineering program offers B.S., M.S. and Ph.D. degrees with emphasis on environmental controls in the areas of air, water, and wastewater. The undergraduate program has an option available in environmental systems.

Chemical engineering was established as a program study in 1914 and began offering environmental courses over twenty years ago. This gradually evolved into the environmental systems option. The program prepares students for careers in the design, sales, and research of environmental/emissions control systems. Support facilities include an environmental monitoring instrumentation lab and the lab facilities of the Chemical Engineering Department.

PROGRAM REQUIREMENTS

General requirements for undergraduate admission include a high school diploma along with scores from either the Scholastic Aptitude Test or the American College Test. Admission to the M.S. program requires an acceptable undergraduate degree with a cumulative average of 3.0 on a four-point scale, and the Graduate Record Exam. The Ph.D. program generally requires an acceptable M.S. degree. An acceptable degree is usually considered to be one in an engineering discipline.

The undergraduate option in environmental systems is flexible and allows students to pursue their own areas of interest. Included in the one hundred and twenty to one hundred and twenty-nine credit hour program are twenty-two hours in chemistry, twelve in math, eight in physics, six in English, three in engineering and fifteen in environmental electives.

A master's degree can be obtained with or without a thesis. The thesis program requires twenty-four hours of course work or independent study, with a minimum of twelve in chemical engineering. Without a thesis, the degree requires at least thirty hours of study of which fifteen must be in chemical engineering, including three hours of research or independent study.

Requirements for the Ph.D include a minimum of ninety hours of credit beyond a bachelor's degree, with between eighteen and thirty-nine credit hours toward a dissertation. At least twenty-four credit hours must be in chemical engineering and twelve hours in a relevant minor field.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of seven faculty members participates in this program, who divide their time almost evenly between teaching and research. Funding for research is provided by the National Science Foundation and New York State.

Currently there are ninety-five undergraduate and twenty graduate students in the program. Many students are career change, coming from the fields of biology and chemistry. About 60 percent of the undergraduates are in-state residents while only about 15 percent of graduate students are in-state. Recruitment is normally done by the university but the program does recruit some of its undergraduates for the graduate program. Some of the undergraduates receive financial assistance in the four of university scholarships based upon need. Graduate student assistance is available in research assistantships and fellowships.

The average number of graduates in both the undergraduate and graduate programs is about fifteen per year with slight variation. About 25 percent of the B.S. students go on to further education and approximately one-third of the M.S. degree graduates continue. Graduates generally experience no difficulties in finding employment, and it is estimated that almost 95 percent work in private industry. Most job placement is informal, accomplished through faculty contacts.

PROGRAM PROJECTIONS

No increase in program activities or faculty is anticipated for the foreseeable future.

COURSE DESCRIPTION (SELECTED)

CEN 511 Environment Monitoring Instrumentation - Experimental techniques of sampling and analysis of gaseous, liquid and solid waste. Principles and operation of modern instruments to measure very low concentrations of air and water pollutants, including the evaluation of typical data. (3 s.h.)

CEN 532 Aerosol Technology - Mechanical, electrical, and physiochemical behavior of aerosol particles. Theories of disposition and filtration of particles from gases, and experimental methods for measuring particle size distributions. (3 s.h.)

CEN 545 Physiochemical Methods in Waste Treatment - General survey on the applicability of chemical engineering unit operations and unit processes in fluid waste treatment. Membrane process, including electrodialysis and reverse osmosis, IPC (Independent Physical and Chemical) process of waste treatment, coagulation, deep bed filtration, and carbon column operation. (3 s.h.)

CEN/MEE 547 Chemistry and Transport of Air Pollutants - Photochemical, thermal, and heterogeneour reactions of gaseous pollutants, transport equations, air pollution climatology, dispersion modeling, and forecasting potential air pollution occurrences. (3 s.h.)

CEN 573 Principles and Design in Air Pollution Control - Fundamental principles of pollution control, design of control processes and equipment for gaseous and particulate pollutants. (3 s.h.)

INSTITUTION: TEMPLE UNIVERSITY

PROGRAM: Environmental Technology (A.T.)
Environmental Engineering Technology (B.S.)

DEPARTMENT: Civil and Environmental Engineering Technology

DEGREE: Associate in Technology (A.T.)
Bachelor of Science (B.S.)

CONTACT: Dr. Frederick B. Higgins
Chairman of the Department of Civil and
Environmental Engineering Technology
Temple University
Philadelphia, Pennsylvania 19122
(215) 787-7816

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering Technology offers two degree programs relating to environmental pollution control; Environmental Technology and Environmental Engineering Technology. The Environmental Technology Associate degree curriculum is oriented toward the training of engineering technicians to perform environmental measurement and control tasks for either industry or governmental agencies. This program is accredited by the Engineer's Council for Professional Development and graduates are trained for positions as air pollution technicians, laboratory technicians, service technicians, technical representatives, and water quality technicians.

The Environmental Engineering baccalaureate curriculum is based on chemistry, biology, civil engineering, and chemical engineering aspects which would be most appropriate to study environmental quality deterioration and to the design of equipment or systems for pollution abatement and control. Students prepare for the practical application of control technology to pollution control and abatement. Students may select electives to emphasize engineering, social or management aspects. Graduates may obtain positions as project engineers with consulting companies in environmental control groups in industry, or in regulatory agencies.

The two programs utilize a wet chemistry laboratory for the analysis of environmental pollutants and an instrumentation laboratory which contains automated air and water pollution monitors. In addition, a bacteriological laboratory is available for students to use. Several pilot treatment plants are also available.

PROGRAM REQUIREMENTS

In order to be eligible for admission at Temple University sixteen units (one unit - one year) of acceptable high school work are required of which ten must include four units of English, two units of college preparatory mathematics, one unit of history, one unit of laboratory science and two units of a foreign language. College of Engineering Technology students are not required to satisfy the foreign language requirement but must instead present two additional units of mathematics and laboratory sciences.

The two-year Environmental Technology curriculum includes 66 semester hours of required courses plus an environmental field operations course (4 semester hours) during the summer between the second and third semesters. The four year Environmental Engineering Technology curriculum includes 124 credit hours of required courses over an eight semester period plus the summer field operations course.

The students participating in these programs can elect a cooperative educational arrangement as an option. Approximately three students participate each semester and the U.S. Environmental Protection Agency office in Philadelphia is the largest employer of Temple University's environmental students.

Although there are no specific departmental grants available to students as financial assistance, Pennsylvania has grants available entitled Pennsylvania Higher Education Agency and Basic Education Opportunity Grants and other forms of federal grants are available.

CURRENT FACULTY, STUDENTS, GRADUATES

Only two faculty professors are engaged in teaching Temple University's environmental courses offered in the two degree programs. However, other full-time faculty in other departments also teach major courses in noise control, solar energy, environmental impact assessment and energy and environment.

There are currently 64 full-time students (nine females) and twelve part-time students enrolled in the baccalaureate program. Eight students (3 females) are enrolled in the associate program. Approximately fifteen baccalaureate students and one to two associate degree students graduate annually. The baccalaureate program has been increasing steadily but not as rapidly as has been expected by program officials. Enrollment in the associate degree program has been low and appears to be declining.

Almost all of the associate degree students transfer into the baccalaureate program. However, only ten to fifteen percent of the Environmental Engineering Technology graduates continue for advanced degrees. Because of a state and city policy of hiring engineers and not technicians, few Temple graduates work for city or state environmental agencies. The U.S. EPA Regional Office in Philadelphia is a consistent employer of Temple graduates (2 each year). Recent graduates have also found employment with local water treatment equipment manufacturers and sales engineering firms (as technical representatives). Because the unavailability of public agency jobs in the Philadelphia area exists, eighty percent find private sector employment.

PROGRAM PROJECTIONS

Temple University plans to offer its first baccalaureate engineering degree program in the fall of 1978. Many of the environmental courses will be incorporated in the engineering curriculum. One day-adjunct instructor and six to seven evening adjuncts are expected to be recruited in the near future to teach energy and environment, air pollution, environmental impact preparation, and computer modelling courses. All will have engineering backgrounds and will teach specific courses on an adjunct basis. The Environmental Technology programs are acquiring a unit operations laboratory in a new building during 1978 and air/industrial hygiene will be taught in its facilities. The laboratory will be equipped with pilot scale water and wastewater treatment plants with capacities of between one-half to one million parts per million capacity.

As baccalaureate enrollment appears to be increasing steadily, a B.S. in Engineering Science with no departmental sponsor will be initiated. Ultimately an environmental engineering major will be developed, but no departmental degrees will be offered.

COURSE DESCRIPTION

10 Introduction to Environment - Evaluation of environmental conditions. (3 s.h.)

11 Energy & Environment - The effects of energy development and use on environmental quality. (3 s.h.)

13 Environmental Chemistry - Basic principles of chemistry and stoicheometry as they relate to environmental pollution measurements and chemical treatment. (3 s.h.)

17 Sanitary Chemistry & Microbiology - Wet analysis of environmental importance; sampling; data handling; standard test; microbiology. (3 s.h.)

24 Environmental Instrumentation - Optical, electrochemical and instrumental methods of analysis; environment applications. (3 s.h.)

31 Pollution Control Processes - Liquid and gas properties of importance in environmental control operations; sedimentation, filtration, membrane processes, adsorption, ion exchange, chemical treatment. (3 s.h.)

33 Environmental Field Operations - Field aspects of environmental engineering: Air and water sampling, stack sampling, bioassay and environmental aspects of planning. (4 s.h.)

110 Air Pollution Control Systems - Principles of design and operation of municipal and industrial wastewater treatment plants. (3 s.h.)

113 Solid Waste Management - Refuse collection and disposal incineration; landfill; composting; recycling; special wastes. (3 s.h.)

115 Water Treatment - Chemical and physical methods of treatment of water supplies. (3 s.h.)

116 Environmental Regulations - View of environmental regulations at the federal, state and local levels. (3 s.h.)

120 Environmental Systems Design - The practical design of pollution control systems in the areas of air, water, solid waste, industrial hygiene and noise. (3 s.h.)

210 Environmental Planning - Planning as a factor in minimization of environmental impact and on preparation of environmental impact statements. (3 s.h.)

211 Energy Resource Development - Current energy sources, available resources and methods of development. (3 s.h.)

390 Independent Study in Environmental - Student permitted to study a regular course on his own during the semesters the course is not offered, enabling student to meet prerequisite or graduation requirements. (2-4 s.h.)

398 Independent Research - Student will be assigned a research project with the approval of the department chairman and conducted under the supervision of a faculty sponsor. (2-4 s.h.)

INSTITUTION: THE PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Air Pollution Control Technology

DEPARTMENT: General Engineering

DEGREE: Associate Degree in Air Pollution Control Technology

CONTACT: Ernest R. Weidhaas
Assistant Dean for Commonwealth Campus
Department of General Engineering
101 Hammond Building
The Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-7589

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The two-year associate degree program leading to the Associate Degree in Air Pollution Control Technology is given at the Berks Campus at Reading, Pennsylvania. The sixth term of the program is taken at the University Park Campus. The program first offered at Penn State in 1971 was one of the first programs of its nature in the nation. This major prepares students for positions as air pollution control technicians, working for a local, state, or federal agency. The air pollution control engineering technician may be responsible for the calibration, installation, and operation of air-sampling and monitoring equipment, investigation of complaints, plant inspections, and source evaluation, and may be expected to make suitable recommendations based on his or her findings.

Support facilities available for the use of the program's students include a mobile van, electrical laboratory equipment and chemical laboratory equipment.

PROGRAM REQUIREMENTS

The program accepts graduates of accredited secondary schools who have completed fifteen Carnegie units of preparatory work. Graduates of three-year senior high schools need only to complete twelve units of work. Required are three units of English and two units of mathematics. One unit of mathematics must be in algebra, and the other in any combination of advanced algebra, plane geometry, solid geometry, or trigonometry.

200

Structured into the curriculum are fifteen credits of chemistry, six credits of English, nine credits of mathematics, twenty-six credits engineering, one credit of computer science, three credits of speech communication, three credits of physics, three credits of meteorology, and six credits of humanities and social science electives. A total of 72-73 credits are required to earn the degree.

Financial assistance is available from a U.S. Environmental Protection Agency special air pollution student loan fund. This assistance is available through the Center for Air Environment Studies at Penn State. If a student works in the air pollution field for two years after graduation, the loan does not have to be repaid.

CURRENT FACULTY, STUDENTS, GRADUATES

One full-time faculty member teaches the program's curriculum. A total of three (all male) full-time students are enrolled in the program. Over the past three years, an annual average of three students receive the associate degree.

According to a relatively recent (June, 1976) placement study conducted by the college, most (50%) graduates have found positions in consulting engineering firms. Another forty percent find government jobs and ten percent continue on for additional education. Several students have transferred to the Water Resources Engineering Program offered at Penn State's Capitol Campus.

PROGRAM PROJECTIONS

The enrollment in this program has been too low to become an effective program. A recent change to a more chemical engineering orientation has been undergone with facilities utilized at the Center for Air Environment Studies. No staff growth can be anticipated as long as enrollment stays low.

COURSE DESCRIPTION

(the following is a partial listing of courses)

Chemical Engineering

802 Chemical Technology - Introductory discussion and problems relating to flow of fluids and transfer of heat. (3 s.h.)

830 Industrial Chemistry - The commercial preparation of important chemicals and derivatives with emphasis upon the chemistry involved and the flow of material. (3 s.h.)

Chemistry

13 Chemical Principles - Includes an introduction to the chemistry of the elements, plus basic concepts and quantitative relations. (3 s.h.)

14 Experimental Chemistry - Introduction to quantitative experimentation in chemistry. (1 s.h.)

15 Experimental Chemistry - Continuation of Chem 14. (1 s.h.)

Electrical Engineering Technology

801 Fundamentals of D.C. Circuits - Fundamental theory of resistance, current, voltage. (3 s.h.)

809 D.C. Circuits Laboratory - Introduction to electrical apparatus, including instruments, their interconnection into basic circuits, observation of circuit behavior, and report writing. (2 s.h.)

814 Electrical Circuits - Direct-current analysis; introduction to basic magnetism and magnetism and magnetic circuits; single-phase circuit fundamentals. (4 s.h.)

Engineering Mechanics

810 Basic Mechanics - Forces; moments; resultants; equilibrium of force systems; introduction to dynamics. (2 s.h.)

811 Elementary Mechanics - Forces; moments; resultants; equilibrium of force systems; friction; centroids and moment of inertia of areas; dynamics of particles. (3 s.h.)

882 Air Resource Management - Introduction to air pollution. Pollutants, sources, effects, air monitoring systems, air quality criteria and standards, governmental control programs and procedures. (3 s.h.)

884 Sampling and Monitoring Program - Instrumentation and site selection, field data acquisition for major air pollutants, data analysis and evaluation. (2 s.h.)

INSTITUTION: THE PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Master of Engineering in Environmental Engineering (M.E.E.E.)
Doctor of Philosophy in Environmental Engineering (Ph.D.)

CONTACT: Dr. Raymond E. Untraver, Head
Department of Civil Engineering
212 Sackett Building
The Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-8391

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Environmental Engineering Program at Penn State was first initiated in September, 1972. It is really an expansion of the Bachelor of Science degree in Sanitary Engineering, a program first started in 1908. At the undergraduate level, the program is designed to provide a basic foundation in engineering supplemented by specialized study in the areas of air, water and solid waste, and radiological protection. All students in the program will receive instruction in one of them by selecting an option for his or her last four terms. A general option is available for those students who wish to postpone specialization to a graduate level program. The major is an interdisciplinary one within the College of Engineering and it is administered by the Department of Civil Engineering. Continuous liaison is maintained with the College of Earth and Mineral Sciences.

The Environmental Engineering degrees at the graduate level are administered entirely by the Civil Engineering Department. The graduate program can also provide specialization in the areas of air, water, or solid waste.

Most students obtain employment with consulting engineering firms, regulatory agencies and industry.

Extensive laboratory facilities are provided for Environmental Engineering in the departments of the two colleges involved with research and instruction. The Department of Civil Engineering has laboratory facilities for instruction and research in the areas of water, wastewater and solid waste. The Department of Mechanical Engineering has laboratories in the area of air pollution control. Additional research and laboratory space is available in the Center for Air Environment

Studies. The Department of Nuclear Engineering operates the Breazeale Nuclear Reactor with laboratory facilities in the area of radiological protection. Facilities are avsilable in the College of Earth and Mineral Science laboratory in the areas of geochemistry, hydrogeology, and mineral processing.

PROGRAM REQUIREMENTS

Candidates with a baccalaureate degree in a field of engineering are eligible for the advanced degrees. The degree should be from an institution accredited by the Engineer's Council for Professional Development. In order to enter the College of Engineering as an undergraduate, three units of English, three units of mathematics (1½ units of algebra, 1 unit of plane geometry, and ½ unit of trigonometry), one unit of science, and eight other units are required during high school preparation.

For the B.S. degree in Environmental Engineering, 140-143 credits are required, depending on the option selected. Required are 67-68 baccalaureate degree requirements, 51 credits of major requirements and 22-24 credits for the option (general, 22; air, 22; radiological, 24; and water and solid waste, 23).

Requirements for the Master of Science degree in Environmental Engineering include 30 semester credits of course work (20 to be completed in residence), a thesis, and a twelve month completion period. No language proficiency is required.

The Master of Engineering degree in Environmental Engineering requires completion of 30 credits in residence with 27 credits in course work and 3 credits directed to the Engineering Report.

The Doctor of Philosophy degree in Environmental Engineering requires completion of a candidacy exam, language exam, comprehensive exam, dissertation, and final oral exam.

A five-year work study program in environmental engineering is available and includes alternating periods of study and employment. Two years of engineering experiences and money to offset educational costs are acquired by students admitted to this program.

At the graduate level, one and one half departmental graduate assistantships are available. Sponsored research projects are the funding sources for additional assistantships.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten full-time faculty members make up the interdisciplinary faculty which teach the undergraduate level courses. Eight are from Civil Engineering (5 water quality; 3 water resources hydrology); one is from Mechanical Engineering (air pollution); and one is from the Nuclear Engineering Department (radiation). Six professors from the

Department of Civil Engineering make up the graduate Environmental Engineering staff. They devote about 70 percent of their time to teaching and 30 percent to research activities. Most research funding is from industry although the City of Philadelphia does provide some funding for research.

There are currently (Fall, 1977) a total of 130 (12-15 female) full-time students enrolled in the undergraduate program. Included are two to three part-time co-op students. At the graduate level, 19 students (1 female) are enrolled in advanced degree programs. An average of 23 undergraduates and eight graduates annually earn degrees from the Environmental Engineering program.

Approximately 20-25 percent of the undergraduates continue on for advanced degrees. Most master's students continue on to other educational institutions for doctorates. In previous years, most (60 percent) of the master's students were continuing on for doctorates at Penn State. Eighty percent of the program's graduates have obtained employment in their field and 70 percent have found jobs in the private sector, mostly with consulting engineering firms. Consulting engineering firms make an active recruitment effort of Penn State students. Only 30 percent of the program's graduates have found positions in government agencies.

PROGRAM PROJECTIONS

The Environmental Engineering Program is now at maximum capacity and little additional growth is projected. No change from the current emphasis is expected. During the last two to three years, the enrollment has increased greater than what was anticipated. Financial constraints prevent the hiring of any additional staff members for the program.

COURSE DESCRIPTION (SELECTED)

Biol 410 General Limnology - Organisms found in inland waters; biological factors affecting their distribution and relationship; intensive studies of our local streams. (3 s.h.)

Biol 435 Ecology of Lakes and Streams - Physical, chemical, and biological characteristics of freshwater environments, with special emphasis on factors regulating productivity in freshwater ecosystems. (3 s.h.)

Bio 481 Aquatic Botany - Identification, collections, and relationships of higher aquatic plant groups; field study of habits. (3 s.h.)

CE 51 Engineering Hydrology - Water sources and losses in nature; effects of precipitation, evaporation, and subsurface percolation on streamflows; flood prediction, water resource management.(2 s.h.)

CE 70 Water Pollution Control -Quantity and quality of municipal and industrial water and waterwater. Unit operations and treatment processes for water pollution control. (3 s.h.)

CE 371 Water and Wastewater Transport Systems - Water storage and transmission; design of water distribution and sewerage systems; pumps and pumping systems. (2 s.h.)

CE 451 Advanced Hydrology - Recent advanced in deterministic, stochastic, and urban hydrology. (3 s.h.)

CE 471 Environmental Sanitation - Public health engineering applications related to communicable diseases, water supply, wastewater disposal, solid wastes, air pollution, food, vectors, and radiation. (3 s.h.)

CE 472 Water Pollution Control Processes - Principles and design of unit operations for water; domestic and industrial wastewater treatment; equipment selection and application. (3 s.h.)

CE 473 Water Quality Management - Water quality criteria and standards; fate and impact of pollutants in aquatic systems; technology available for wastewater renovation. (3 s.h.)

CE 476 Solid Waste Management - Solid waste collection, salvage and disposal techniques for municipalities and industries; cost analyses; legislation; management; financing; design optimization. (3 s.h.)

CE 570 Physical Chemical Treatment Processes I - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (2 s.h.)

CE 571 Physical Chemical Treatment Processes II - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (3 s.h.)

CE 572 Biological Treatment Processes - The theory of biological processes used in the treatment of municipal and industrial wastewaterss. (3 s.h.)

CE 574 Laboratory Analyses in Water Quality Control - Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control. (3 s.h.)

CE 575 Industrial Waste Treatment - Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. (2 s.h.)

CE 577 Treatment Plant Design - Design of works for the treatment of water and wastewater for municipalities and industries. (1-6 s.h.)

CE 579 Aquatic Microbiology - Ecology and physiology of microorganisms of inland waters, estuaries, and oceans; microbiology of wastewater treatment. (3 s.h.)

CE 580 Stream and Estuarine Analysis - Quantitative assessment of advection, reaction, and dispersion processes in polluted waters; reaeration theory; eutrophic systems; analog simulation. (3 s.h.)

FS 430 Air Pollutants from Combustion Sources - Generation of pollutants in combustion chambers; reduction by combustion control; pre- and post-combustion treatment of fuels and effluents.

HPA 420 Environmental Health - Identification, evaluation and control of environmental hazards. Biological and social considerations of the interaction of human populations with their physical environment. (3-6 s.h.)

ME 58 Acoustics and Noise Control - Sources, measurement, description of environmental noise, transmission loss, noise reduction at source by absorption, isolators and mufflers, noise measurement exercises. (3 s.h.)

ME 458 Noise Control in Machinery - Nature of noise sources in machine elements and systems. Propagation and reduction of noise. (3 s.h.)

METAL 460 Pollution Control in the Mineral Process Industries - Recycle, utilization and pollution control of air, water, and solid wastes from mineral processing plants. Pollution control through process modification. (3 s.h.)

METEO 310 Introduction to Atmosphere Science - Survey of atmospheric processes and analytical methods of atmospheric science. (3 s.h.)

METEO 452 Hydrodynamics of the Atmosphere - Equations of motion; circulation and vorticity; elements of turbulence theory and perturbation theory; introduction to numerical weather prediction. (3 s.h.)

METEO 453 Atmospheric Thermodynamics - Thermodynamic properties of the atmosphere with emphasis on water vapor; applications to forecasting problems. (3 s.h.)

METEO 475 Chemistry of the Atmosphere - Chemical properties of atmospheric components and contaminants. Dispersion and removal processes in connection with cloud physics, circulation, and air pollution. (3 s.h.)

MICRB 400 Introductory Environmental Microbiology - Elementary ecological relationships of microorganisms in the biosphere; role of bacteria in water pollution and purification. (2 s.h.)

MN EC 484 Political Economy of Energy and the Environment - Energy-its nature, use, markets and environmental impacts. (3 s.h.)

MNG 400 Mining and our Environment - For nonmining students. Nontechnical treatment of mining methods, practices, and role in today's civilization; socioeconomic and environmental problems. (3 s.h.)

NUC E 428 Radioactive Waste Control - Nature, sources, and control of radioactive wastes; theory and practice of disposal processes. (3 s.h.)

INSTITUTION: THE PENNSYLVANIA STATE UNIVERSITY

PROGRAM: Environmental Pollution Control

DEPARTMENT: Intercollege

DEGREE: Master of Science (M.S.); Master in Environmental Pollution Control (MEPC); Master of Engineering (ME)

CONTACT: Dr. John B. Nesbitt
Charge of Graduate Programs in Environmental Pollution Control
226 Merrell R. Fenske Laboratory
Pennsylvania State University
University Park, Pennsylvania 16802
(814) 865-1226

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

First initiated in 1971, the Environmental Pollution Control Program is an intercollege program dealing with various aspects of the control of air and water pollution and the disposal of solid wastes. Options are available in: Air Environment; Basic Physical and Biological Sciences; Environmental Health; Environmental Resource Management; Land Environment; Mathematics, Statistics, and Computer-Science; Noise; Planning; Pollutant Control in Industrial Processes; Radiological Protection; Systems Analysis; Water Resources - Quantity; and Water Resources Quality. An interdisciplinary faculty committee and participating departments provide graduate instruction. Other graduate faculty members other than those in the committee have a teaching and/or research interest in the area of environmental pollution control. Graduates are prepared to enter positions with consulting engineering firms, state, local, and federal regulatory agencies, and in private industry. Many have found positions with the Pennsylvania Department of Environmental Regulation and the Department of Transportation. Some have found employment with the U.S. Geologic Survey and EPA, for example. They have served in the capacities of operation plant inspectors, water or air pollution control specialists (not engineers), engineering assistants or technicians,and have prepared environmental impact assessments for consultants.

Research facilities utilized by the program's students are those maintained by the various participating departments at the University. There are none specifically designated for the Environmental Pollution Control Program. Research work conducted by students are sponsored by the various departments associated with the program.

PROGRAM REQUIREMENTS

Admission into the program is granted upon the recommendation of the head of the academic department in which the student plans to complete a program and the environmental pollution control program faculty committee. Mathematics through integral calculus, and one year of work in both general physics and chemistry is normally required for admission. Considered for admission are students with appropriate backgrounds in mathematics and science and a 2.75 junior-senior average.

Students enrolled in the Environmental Pollution Control Program are required to pass 9 credits of EPC core courses and 3 credits of EPC 590 seminars. One credit of the seminar in air is given during the fall term, one in water is given during the winter term, and one credit in solid waste management is offered during the spring. The core courses are: CE 472, Water Pollution Control Processes; CE 476, Solid Waste Management; and ME 470, Fundamentals of Air Pollution. Students not choosing to major in Water Pollution Control may substitute CE 473, Water Quality Management for CE 472, Water Pollution Control Processes.

In addition to the 12 credits of core courses and seminars, a minimum of 12 of the remaining 18 credits required for the master's degree must be selected from the EPC recommended courses list.

Master of Environmental Pollution Control: at least 9 of the student's total credits must be at the 500 level and these 9 credits should not include EPC seminars or credits taken to write the MEPC paper.

Master of Science in Environmental Pollution Control: at least 18 credits at the 500 and 600 level and these may include the EPC Seminars; and for most departments a thesis must be written.

Students can develop, with the help of an advisor in the selected department of affiliation, a program that will specialize in one area yet provide a basic comprehension of the problems encountered in other areas of environmental pollution control. The proposed program study, approved and signed by the student's advisor, is normally submitted to the program office within the first three weeks.

The student advisor, the head of the department of affiliation, and the EPC Program Chairman, determine the requirements concerning the research paper or thesis.

The university provides eight terms (2 years) of financial assistance to graduate assistants. Additional graduate assistance is provided through the student's departmental affiliation and usually involves work on funded research projects.

CURRENT FACULTY, STUDENTS, GRADUATES

A total of forty faculty members contribute to the offering of the courses in the program. Thirty-three faculty are senior graduate faculty members and seven are associate graduate faculty members. They devote about 70 percent of their time to teaching activities and 30 percent to research.

There is a total of 26 full-time students enrolled in the Environmental Pollution Control Program. All except one student are male and there is only one part-time student in the program. About one-half of the students are affiliated with the Civil Engineering Department and the rest are from Agronomy, Veterinary Science, Mining Engineering, Geography, Meterology, Food Science, and Biological Health. Ten to fifteen students have graduated annually in recent years and the four-year average is 14 students. Enrollment and the number of graduates have remained relatively stable over the past couple of years.

The Environmental Pollution Control Program is designed to be a terminal Master's program. Resumes of students enrolled in the program and the Center for Air Environmental Studies are published and mailed to prospective employers. This has resulted in rather successful placement of graduates. About 95 percent of graduates find employment in their field and the rest are unknown. Approximately 30 percent find positions in governmental agencies, 40 to 50 percent in the private sector, and 20 percent in academia and other areas. Most finding positions with the Pennsylvania Department of Environmental Regulation serve as operations plant inspectors, conducting stream surveys, water or air pollution control specialists. Those finding positions with consulting firms are employed as engineering assistants or technicians, prepare 208 Areawide Planning Studies, prepare environmental impact assessments, and in sales. Some graduates take further fluid mechanics or waste treatment courses and thus obtain engineering work with consulting firms.

PROGRAM PROJECTIONS

Because of time and fiscal constraints, no change is expected to develop with the Environmental Pollution Control Program. The present orientation of the program is considered to be adequate in structure and no additional faculty members are expected to be recruited. There appears to be a leveling off of enrollment in the program to 25 to 30 per year.

COURSE DESCRIPTION

(the following is a partial listing of courses)

CE:

451 Advanced Hydrology - Recent advanced in deterministic, stochastic, and urban hydrology. (3 s.h.)

472 Water Pollution Control Processes - Principles and design of unit operations for water; domestic and industrial wastewater treatment; equipment selection and application. (3 s.h.)

474 Management of Water Pollution Control Processes - Personnel requirements, record systems, unit process operation and control, laboratory control and equipment maintenance systems. (3 s.h.)

476 Solid Waste Management - Solid waste collection, salvage and disposal techniques for municipalities and industries; cost analyses; legislation; management; financing; design optimization. (3 s.h.)

554 Urban Hydrology - Several hydrograph methods. Design storm and IUH application; airport drainage; flood plains; impact of urbanization upon groundwater and sediment. (3 s.h.)

570 & 571 Physical Chemical Treatment Processes I & II - The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. (2-3 s.h.)

573 Problems in Environmental Pollution Control - Investigations, analyses, and reports on current topics in environmental pollution control. (3 s.h.)

575 Industrial Waste Treatment - Surveys and data analysis; use of unit processes to meet regulatory agency requirements; disposal of gaseous and solid residues. (2 s.h.)

Mechanical Engineering

405 Air Pollution Control Systems - Small particles formation, properties, and behavior; equipment design and instrumentation; air pollution control, atomization, mass transfer, filtration. (3 s.h.)

458 Noise Control in Machinery - Nature of noise sources in machine elements and systems. Propagation and reduction of noise. (3 s.h.)

470 Fundamentals of Air Pollution - Nature, sources, transport, control, and effects of pollutants; sampling methods; air quality criteria and standards, economics, and planning. (3 s.h.)

Microbiology

400 Introductory Environmental Microbiology - Elementary ecological relationships of microorganisms in the biosphere; role of bacteria in water pollution and purification. (2 s.h.)

INSTITUTION: UNIVERSITY OF CINCINNATI

PROGRAM: Air Pollution, Industrial Hygiene

DEPARTMENT: Environmental Health

DEGREE: Master of Science in Air Pollution or Industrial Hygiene (M.S.)
Doctor of Philosophy in Air Pollution or Industrial Hygiene (Ph.D)

CONTACT: Dr. Bernard E. Saltzman
Environmental Hygiene Program
Department of Environmental Health
Room 107, Kettering Lab
University of Cincinnati
Cincinnati, Ohio 45267

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

According to a recent publication by the Department of Environmental Health at the University of Cincinnati, its "scientific and educational interests . . . are largely a response to the need to understand the nature of environmental hazards, to probe their biologic and ecologic impact, particularly their effects on human health, and to develop methods of prevention and control." As part of that response, graduate study sequences in Industrial Hygiene and Air Pollution were developed in 1954 and 1960 respectively. The Industrial Hygiene program is the second or third oldest in the U.S., and the university holds the nation's oldest grant for Air Pollution training. The Air Pollution program is conducted jointly with the Department of Civil and Environmental Engineering in the College of Engineering. The bulk of students following the Industrial Hygiene program are employed in the private sector, while those students trained in Air Pollution usually find jobs in control agencies.

The Department of Environmental Health and the Industrial Hygiene program within it are heavily engaged in research and outreach programs. The faculty offer one to two week courses for professionals in industrial hygiene and one- to three-day courses on occupational health hazards for employers and employees of small businesses in an area within 150 miles of Cincinnati. The Department also offers a weekly seminar open to the university community and the public to which "distinguished leaders in their specific fields are invited to present new scientific information and new approaches to critical problems."

Facilities include laboratories in air flow measurement and calibration, dust sampling and evaluation, instrument calibration, air sampling, noise measurement and control, industrial hygiene chemistry, and respiratory protection. The nearly research units of the National Institute for Occupational Safety and Health (NIOSH) and the Environmental Protection Agency (EPA) provide excellent facilities to students and staff; both federal units maintain a close relationship with the Department. NIOSH has recently designated the University of Cincinnati as one of nine Educational Resource Centers in the country in industrial hygiene and safety, industrial health nursing, and occupational medicine; the center is charged with developing an outreach program and providing materials to regional schools in these industrial areas.

In addition to the $500,000 annual NIOSH grant (five years), the program has received funding from EPA, the Energy Research and Development Administration (now the Department of Energy), and the Occupational Safety and Health Administration. Grant monies are critical to the program because they are the major source of faculty salaries and graduate student stipends.

PROGRAM REQUIREMENTS

Students entering the programs in Industrial Hygiene and Air Pollution must have a baccalaureate degree and have majored in chemistry, biology, engineering, or related fields. Formal requirements for the M.S. degree are the satisfactory completion of at least 45 quarter credit hours of graduate courses, including research, and the preparation of a thesis. The Ph.D. degree requires completion of 135 graduate credits, 45 of which must be earned in residence at the University of Cincinnati, and an acceptable dissertation. All students complete a core program of lecture courses, seminars, and research in the Environmental Health Department and also a group of electives preparing each of them for a chosen area of specialization in professional practice or teaching. The time required for completing the M.S. degree varies from one to two years. For a majority of students with a B.S. degree, four years of graduate work are necessary to complete the requirements for the Ph.D. degree

CURRENT FACULTY, STUDENTS, GRADUATES

Ten full-time faculty members, who devote an appropriate fraction of their time to teaching and the remainder to research, serve students in these programs. As of Autumn 1977, enrollment figures were as follows:

AIR POLLUTION

M.S.		Ph.D.	
Full-time	4	Full-time	2
Part-time	4	Part-time	6

INDUSTRIAL HYGIENE

M.S.		Ph.D.	
Full-time	23	Full-time	8
Part-time	22	Part-time	0

The differences in enrollment between these two areas is in part due to the financial support available to graduate students. Graduate student support currently comes from a variety of sources: EPA loan fund, NIOSH stipends, ERDA stipends in Industrial Hygiene, research work on department grants and contracts, summer employment with EPA and NIOSH, armed forces service, and foreign governments. The shrinking support from EPA for Air Pollution training has reduced the number of students sustained in this area of concentration, while growing support from NIOSH and OSHA continues to draw increasing numbers of students into the Industrial Hygiene program.

For both programs combined, there are approximately 16 M.S. and 2-3 Ph.D. degrees awarded annually. Upon completion of the M.S. degree, approximately 10 percent continue work on a Ph.D. and many do so at the University of Cincinnati. Of the 105 graduates over the last 8 years, 60 percent have taken jobs in the private sector and 40 percent have entered government work. There are numerous job opportunities due to the legislation requiring industry to provide safe working conditions.

PROGRAM PROJECTIONS

The declining financial support in Air Pollution makes the future of that program tenuous; the faculty can be sustained through other funding sources, but the graduate students cannot. There has been some discussion related to expansion of the program into the water pollution area. The NIOSH Educational Resource Center grant will help to build the Department's Industrial Hygiene program and develop a graduate program in Industrial Safety.

COURSE DESCRIPTION

Environmental Health: 701, 702, 703 Environmental Health Seminar - Lectures and discussions covering a broad range of problems in environmental health led by guest lecturers in their field. (1 q.h. each qtr.)

707, 708, 709 Environmental Hygiene Technology I - Lectures, demonstrations on problems arising from man's environment. Industrial hygiene, air pollution fundamentals and practices. (3 q.h. each qtr.)

725, 726, 727 Teaching Practicum in Environmental Health - Practice of assisting and teaching in environmental courses by special arrangement with faculty member who will provide supervision. (2 q.h. each qtr.)

741, 742 Air Sampling and Analysis I and II - Calibration of sampling equipment, collection, analysis of pollutant gases, vapors, particulate matter. (3 q.h. Aut., Win. qtr.)

747, 748 Environmental Sanitation - Basic principles, practices of water and public health engineering. Municipal refuse collection, disposal; food, milk sanitation; pest control; housing, recreational sanitation. (2 q.h. each qtr.)

751, 752 Occupational Dermatology - Applied physiology and anatomy of skin. Etiology, evaluation, treatment, and prevention of environmental dermatoses. (2 q.h. Aut., Win. qtr.)

771 Biological Effects of Air Pollutants - Investigation and identification of the health effects of air pollutants on human beings, other animals, and plants. (2 q.h. Spr. qtr.)

772 Energy and Environment - Environmental impact studies of energy generation and utilization including fossil-fuel, nuclear power, waste recycling. (3 q.h. Win. qtr.)

775 Industrial Hygiene Laboratory - Evaluation of chemical, physical hazards in industrial workplaces. Potential hazards include noise, glare, heat, dust, solvents, electromagnetic radiation. (3 q.h. Spr. qtr.)

779 Industrial Ventilation - Principles of air flow through ventilation systems and their design for industrial uses starting with simple foods and progressing through complex systems. (2 q.h. Win. qtr.)

780 Air Pollution Meteorology - Theory, application of meteorology applied to air pollution, including diffusion computations, tracer studies, urban diffusion experiments, air quality cycles, pollution incidents. (4 q.h. Win. qtr.)

781 Introduction to Occupational Health - Principles, philosophies, basic concepts of medical engineering, and other disciplines in research and practice of occupational health. (1 q.h. Aut. qtr.)

782 Toxicology - Introduction - Entry, action and elimination of toxic chemicals; dose-response relationships; experimental toxicology, design, interpretation and application of the data. (3 q.h. Win. qtr.)

785 Introductory Physiology - Basic biological principles with lectures, demonstrations on structure function in mammals. (3 q.h. Aut. qtr.)

790 Physical Aspects of the Environment - Principles and techniques of recognizing and evaluating problems of non-ionizing radiation, ultarviolet, visible, infrared, and microwave. (1 q.h. Spr. qtr.)

791 Master's Thesis Research - Credits to be arranged.

792 Principles of Ergonomics - Concepts, criteria to achieve optimal mutual fitting of capabilities of the worker. Biomechanics, (heat, cold, vibration, noise, chemicals) fatigue, vigilance, behavioral factors. (2 q.h. Spr. qtr.)

796 Introduction to Statistics - Descriptive statistics, probability, estimation, statistical errors, parmetric and nonparametric hypothesis testing, statistical fallacies. Emphasizes applied-practical aspects. (4 q.h. Spr. qtr.)

834, 835, 836 Environmental Quality Management- Seminar encompassing social, technical, economic, and institutional issues of water, solid wastes, noise, and community development programs. (2 q.h. each qtr.)

873 Basic Industrial Safety - Content, administration and implementation of safety programs in industry. Covers good practices and governmental regulations. (2 q.h. Aut. qtr.)

875 Basic Health Physics - Evaluation of exposures to ionizing radiation. Air sampling, personal protection and monitoring of industrial exposures. (2 q.h. Win. qtr.)

877 Theory and Applications of Aerosol Technology - Applications of industrial aerosol technology: sampling, characterization, statistical methodology. (2 q.h. Spr. qtr.)

901, 902, 903 Instrumental Methods of Analysis of Pollutants I, II, III - Lecture lab. Autumn: Chromatography; Winter: Air monitoring instrumentation; Spring: Spectroscopy. (3 q.h. each qtr.)

904, 905, 906 Environmental Hygiene Technology II - Field trips to representative industrial plants to illustrate principles of industrial operations and methods employed in controlling physical, chemical hazards. (3 q.h. each qtr.)

973 Design of Environmental Quality Monitoring Programs - Objectives, types of standards and monitoring programs, statistical aspects of monitoring and of anlytical quality control. (2 q.h. Spr. qtr.)

991 Doctoral Disseration Research - Credits to be arranged.

771-5; 871-5;971-5 Special Topics-Air Pollution - Seminars, or tutorial sessions dealing with special topics in air pollution related to research and application basic to field of environmental health. (cr. arr.)

781-5; 881-5; 981-5 Special Topics - Industrial Hygiene - Seminars or tutorial sessions dealing with special topics in industrial hygiene as related to research and application basic to field of environmental health. (cr. arr.)

INSTITUTION: THE UNIVERSITY OF DELAWARE

PROGRAM: Environmental Engineering

DEPARTMENT: Multidisciplinary (sponsored by College of Engineering)

DEGREE: Master of Applied Science
Master of Engineering in one of the departmental areas
Doctor of Philosophy in Applied Science
Doctor of Philosophy in Chemical Engineering
(or Applied Science)

CONTACT:
Dr. Lloyd A. Spielman
Committee Chairman of Environmental Engineering Program
Rm. 356, Dupont Engineering Building
University of Delaware
Newark, Delaware 19711
(302) 738-2431

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The College of Engineering in 1970 established an interdepartmental program in environmental engineering involving the departments of engineering, chemistry, and biology. This multidisciplinary program is available at the master's and Ph.D. level to all graduate students in engineering and students whose undergraduate majors were in chemistry, physics, or the biological sciences. Major subject areas include air and water pollution control, agricultural effects of pollutants, and environmental resources. The purpose of the program is to enable students with varied engineering and scientific backgrounds to increase markedly their ability to apply the tools and training of engineering to solve environmental problems. Students are first admitted to one of the engineering departments.

The degree requirements for this program are determined by the engineering departments to which the student is admitted. The environmental engineering program is coordinated by an Environmental Engineering Committee comprised of members from each of the departments of the College. Members of the Committee are available to assist students in developing a program of study oriented toward the student's area of special interest in environmental engineering.

The Civil Engineering Department has facilities for research in the environmental engineering disciplines with a supporting machine shop for constructing specialized research equipment. The environmental engineering laboratories contain equipment for conducting physical and chemical tests, as well as standard apparatus for chemical and biological analyses of water, wastewater, and air. The department also has access to late model analog and digital computing facilities for both instruction and research. Research in the chemical engineering laboratories includes air and water pollution control (particularly as related to abatement by catalytic means).

PROGRAM REQUIREMENTS

Applicants wishing to enter the program must first fulfill the requirements of the engineering department with which they want to be affiliated. Program officials state that undergraduates must have taken courses in environmental biology, general geology, chemistry and introductory environmental engineering if they enter the graduate program as University of Delaware undergraduates.

Candidates for the master's degree may pursue either the Master of Applied Science degree or a master's degree in one of the departmental areas. At the Ph.D. level, students in civil engineering and mechanical engineering work toward a Ph.D. in Applied Science and those in chemical engineering pursue the Ph.D. in Chemical Engineering or Applied Science.

The degrees of Master of Chemical Engineering (M.Ch.E.), Master of Civil Engineering (M.C.E.), Master of Electrical Engineering (M.E.E.), and Master of Mechanical and Aeorspace Engineering (M.M.A.E.) are conferred under the direction of those departments. General requirements for the master's degree in the College of Engineering include completion of 24 semester hours of approved course credit or equivalent, plus 6 hours thesis with an average grade of B (residence and foreign language not required). Six hours of thesis or 6 hours of research, or a combination of both are allowed. The minimum amount of credits without thesis is 30 semester hours. Students usually in the non-thesis program are required to pass a comprehensive examination. A maximum of 9 credit hours transferred from continuing education or from another institution may be applied to the degree hours required. For the Master of Civil Engineering, the student may elect, after consultation with a faculty advisor, to replace the thesis with nine credit hours of additional course work and a comprehensive examination.

For the Master of Applied Sciences degree, the requirements of the College of Graduate Studies must be satisfied. These require 30 credits, of which 6 shall be a thesis. In addition, 12 hours of course credit obtained in 800 level courses are normal requirements for the degree.

General requirements for the Doctor of Philosophy degree include at least three academic years of work subsequent to the baccalaureate degree. At least one continuous academic year must be devoted exclusively to full-time study in the major field at the University. Students are also expected to pass comprehensive and final examinations and prepare a thesis. Theses may be written in absentia in chemical, civil, and mechanical and aerospace engineering.

For the Ph.D. degree in Applied Sciences, both oral and written examinations are given by the student's individual graduate committee after completion of the foreign language requirements which is at the discretion of the student's advisory committee. Instead of majors or minors, the applied sciences program required proficiency in the area of interest and the area of mathematics, physical and engineering science.

Full-time graduate students are eligible to apply for fellowships, traineeships, assistantships and loans. University fellowships are awarded to graduate students on an all-University basis and are unrestricted as to the student's field of graduate study. Each provides a stipend of $2,800 for the academic year and tuition is remitted. Industry, foundations, and private individuals have donated funds to support a number of fellowships for University graduate students. Teaching assistants receive stipends ranging from $2,800 to $3,300 for the academic year and tuition is remitted. Eighty percent of the full-time students receive some form of financial assistance which mostly consists of research assistantships and fellowships. Sixty percent of the full-time students receive research assistantships or fellowships; twenty percent receive teaching assistantships; and twenty percent support themselves.

CURRENT FACULTY, STUDENTS, GRADUATES

Four full-time faculty members contribute to the teaching of the program's curriculum. Two post-doctorates are involved in full-time research. Most of their research funding is for wastewater research.

Current enrollment (Fall, 1977) in the master's program is 14 full-time (60%) and 15 part-time students. Only one of the full-time students and four of the part-time students are female. Most of the graduate students spend two years in residence to complete the requirements for the degree. The enrollment in the M.S. program has remained constant over the last few years. Total enrollment in the program is currently 30 (including one Ph.D. candidate)

It is estimated that 6 M.S. students and 1 Ph.D. annually receive degrees on the average. It is estimated that 70 percent of the graduates find private sector jobs (40% consulting, 30% industry). Some find positions in chemical engineering, mobile environmental engineering, research, and consulting jobs have been found in organic recycling of wastes. Also, a few students have obtained positions at Dupont which is located nearby. One part-time student holds a position as head of environmental engineering at Aberdeen Proving Ground. A smaller percentage of graduates (30%) hold academic or governmental positions. Some of the part-time students are administrators of local environmental agencies and take additional course work. Also, some of the part-time students are degree bound. An advantage to part-time students is the fact that all of the graduate course offerings in the program are offered at 4:30 P.M. or later.

PROGRAM PROJECTIONS

It is not anticipated that the program will significantly increase in enrollment or structure in the next few years. Because of the multi-disciplinary nature of the program, additional faculty members can be recruited to teach courses in other areas of interest.

COURSE DESCRIPTION (SELECTED)

GEO 601 Environmental and Applied Geology - The application of geologic principles to matters of environmental concern. (2 s.h.)

CE 331 Introduction to Environmental Engineering - An introductory course in which the student is exposed to interactions within the environment and to the associated engineering problems. Discussions of air and water supply, wastewater treatment, solid wastes, industrial wastes, and their effect on the environment. (3 s.h.)

CE 431 Design of Environmental Control Facilities - Concepts of chemistry, biology, and engineering applied to design of systems for collection, transportation, and treatment of water and wastewater; introduction to water and air quality of criteria; stream pollution. (3 s.h.)

CE 443 Water Resources Engineering - Study of the development, use and allocation of water for irrigation, navigation, flood control, hydropower, water supply, conservation and recreation. (3 s.h.)

Graduate courses:

CE 630 Environmental Health Engineering - Broad application of engineering principles to environmental problems. (3 s.h.)

CE 633 Physical Aspects of Environmental Engineering - Physics of particulate matter in air and water. (3 s.h.)

CE 635 Air Resources Engineering - Air pollution - its causes, effects on environment; and control. (3 s.h.)

CE 637 Water Quality and Pollution - Water quality standards and criteria for various beneficial uses of water. (3 s.h.)

CE 831 Theory of Water Treatment - Application of chemical, biological, and engineering techniques to water treatment processes; aeration, sedimentation, filtration, disinfection, control of taste and odors, etc. (3 s.h.)

CE 832 Theory of Wastewater Treatment - Composition of wastes. Treatment and disposal of sludges produced at wastewater treatment plants. (3 s.h.)

INSTITUTION: UNIVERSITY OF FLORIDA

PROGRAM: Air Pollution

DEPARTMENT: Environmental Engineering Sciences

DEGREE: Master of Engineering (M.E.)
Master of Science (M.S.)
Engineer
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. E. E. Pyatt, Chairman
Department of Environmental Engineering Sciences
University of Florida
Gainesville, Florida 32611
(904) 392-0841

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Although departmental status was authorized in 1966 by the Board of Regents, its geneology may be traced as far back as 1941 to the Department of Civil Engineering. In an effort to not undermine the environmental endeavors of other departments in the College of Engineering, its first name was the Department of Bio-environmental Engineering. This title was conclusively found inappropriate when a correspondent addressed a piece of mail to the Department of Bayou-environmental Engineering. So in 1968 it was renamed the Department of Environmental Engineering Sciences.

The field of environmental engineering is extremely broad; as a result of this, the department has identified several areas on which the student may focus his/her program: air pollution, environmental biology, environmental chemistry, environmental resources management, radiological health, solid wastes, systems ecology, water pollution control, and water supply.

In as many cases as possible, the facilities of the air pollution program have been organized to form specific functional laboratories. A photochemical reactions laboratory has been developed where various types of exposure chambers and gas handling equipment are available for the study of photochemical and thermal reactions under controlled conditions. Extensive aerosol generation equipment and equipment for sampling and analysis, including particle counting and sizing, is provided in an aerosol research laboratory.

A gas chromatography laboratory has dual-column equipment and all detection means which are currently available. The spectrophotometry laboratory includes the common wet chemistry units in addition to an infrared spectrophotometer equipped with attachments including scale expansion, 10-meter gas cell, and pelletizing equipment. A mass spectrometer is available in the Water and Waste-Water laboratories. Additional sophisticated infrared, ultraviolet, and X-ray equipment exists in other departments and may be used by students for non-routine work. An industrial hygiene laboratory has been developed for teaching purposes. An exposure, or toxic mixture, laboratory features a ten cubic meter stainless steel chamber for material or animal exposures, or for the preparation of controlled gas mixtures.

Typical research projects are: Instrumental Methods for Air Pollution Measurements, Aerosol Dynamics and Mechanics, Photochemistry of Air Pollutants, Air Pollution Dispersion Modeling, Reactions of Sulfur and Nitrogen Oxides in Air, Formation of Nitrosyl Chloride in Air, and Mass Monitoring of Aerosols.

Graduates of the air pollution concentration are trained in air pollution dispersion, measurement, engineering control, and broad atmospheric chemistry, including kinetics.

PROGRAM REQUIREMENTS

Admission to the University of Florida's Graduate School requires an undergraduate degree from an accredited institution with a 3.0 average (on a 4.0 scale) during the junior and senior years, Graduate Record Examination scores, and other evidence of one's ability to do graduate level work.

Two distinct master's programs are available to graduate students in the Department of Environmental Engineering Sciences, depending on their educational background and professional goals. Students who possess undergraduate degrees in engineering or a basic science may pursue the Master of Science degree through a program in Environmental Sciences. Persons with degrees in a non-technical field may be admitted to this program. Commonly, these people have completed at least one year of college-level course work in three of the following four areas: chemistry, biology, calculus, and physics. A program in Environmental Engineering leads to a Master of Engineering degree which is accredited by the Engineers' Council for Professional Development. Those who wish to enter this program must be graduate engineers. Other persons wishing to enter this program will be required to take sufficient articulation work to bring their backgrounds into substantial agreement with those having undergraduate engineering training.

Any student who has plans to pursue a doctorate degree is encouraged to prepare a master's thesis; however, others in either the M.S. or M.E. programs have the option of doing a thesis or not doing one, in which case a technical paper must be prepared and presented at a seminar during their final quarter in residence. The minimum registration for a master's degree with a thesis is 45 quarter credits, 36 of which are to be taken in course work and nine in thesis preparation. Thesis option students must take at least eighteen units of Environmental Engineering Sciences course work and at least eighteen units of graduate level courses (numbered 600 or higher). The non-thesis option requires a minimum of fifty-four units, twenty-seven of which must be taken within the department and at least twenty-four at the 600 level or above. Students in each option must take eight credits outside of the department. These courses may constitute a designated minor or they may be spread over varied disciplines.

The departmental core requires environmental biology, environmental chemistry, statistics, and computer programming of all students; beyond this, it is the responsibility of the student and his/her supervisory committee to approve what program of courses is selected. Each student must pass a written and/or oral examination upon completion of his/her course work.

In addition to those courses which are required in the core, a possible schedule of courses which would complement an air pollution concentration includes ENE 550 - Atmospheric Pollution, ENE 650 - Occupational Health, ENE 656 - Environmental Meteorology, ENE 654 - Air Pollution Sampling and Analysis, ENE 671 - Aerosol Mechanics and Dynamics, ENE 655 - Air Pollution Control Measures, ENE 671 - Air Pollution Chemistry, and ENE 652 - Environmental Instrumentation.

An Engineer degree is available for engineers who require additional knowledge beyond the master's degree. This degree requires a minimum of forty-five units of graduate work beyond the master's degree, and it falls midway between the master's and the Ph.D. in the amount of work required. This degree is not widely recognized so its pursuit is not encouraged. It is important to realize that an Engineer degree does not suffice in any way as partial fulfillment of the Ph.D. requirements.

To be admitted to the Ph.D. program, one must have a master's degree. Once admitted, a three person supervisory committee is appointed to guide the student's research and program of study. A minimum of eight quarters in residence is required to complete the program. Very little course work is specified in order to allow the student and his/her committee a maximum of flexibility in tailoring a program to the needs of the individual. With the committee's approval, a student may choose one or more minor fields, restricted only by the fact that the minor should be unified relative to a clear objective. The Ph.D. candidate must demonstrate proficiency in a language other than his/her native tongue, or must complete a non-technical minor outside of the major field of interest, to be chosen by the supervisory committee. After all of the language requirement has been met, and substantially all of the course work is complete, the student must take a qualifying examination for candidacy status for the doctor's degree. The dissertation represents the culmination of the candidate's program, and following its defense the Ph.D. degree is awarded.

CURRENT FACULTY, STUDENTS, GRADUATES

The seventeen person faculty usually expends half of its efforts on teaching and half on research, with the exception of three full-time instructors. Two of these seventeen faculty are chiefly involved with the air pollution option.

Enrollment in the graduate program in Environmental Engineering Sciences peaked in 1973 with one hundred and twenty-five students. There are now one hundred and three people enrolled, fifteen of whom are doctoral students. This option used to have provision for seven or eight Environmental Protection Agency training grants, but this is no longer the case. Fourteen research contracts supply financial assistance for graduate students in this program. The enrollment is down for the reason that they are not able to provide financial assistance to more of the students.

During 1977 a total of thirty-two graduate degrees were conferred in this department. There were four recipients of the M.E., twenty-two of the M.S., and six of the Ph.D. The Engineer degree has never been awarded. It is not determined how many of these degrees are specific to the air pollution concentration.

A follow-up study of graduates between 1971 and 1973 shows that of one hundred and thirty-three people who earned master's degrees, twenty-five were employed by consulting firms (most are M.E. graduates), fourteen were hired by industry, nineteen pursued additional degrees, thirteen went to work with health departments, nine accepted positions with EPA and the U.S. Public Health Service, fourteen are working with other governmental agencies, and six are teaching in colleges or universities.

PROGRAM PROJECTIONS

The future of this and other similar environmental programs is keenly dependent upon the quality and quantity of assistance and support which is received. It has already experienced a slump in enrollment because of training fund cuts. It is anticipated that the demand for graduates such as these will be great as our environmental situation grows increasingly complex. During recent years, there have been many more positions available for environmentalists than there are properly qualified specialists to fill them.

Because of the withdrawal of federal support for graduate education, competition for financial aid will become increasingly intense. It is felt, however, that as students forget that federal funds existed in the past, the enrollment figures will stabilize or increase.

COURSE DESCRIPTION (SELECTED)

ENV 520 Environmental Biology - Basic cellular organizations and processes related to waste treatment. Role of environmental engineering in maintaining stability of fresh water, marine and terrestrial ecosystems. (4 q.h.)

ENV 522 Environmental Health - Effects of environmental pollution upon health. Methods of evaluation, treatment, and prevention of pollutants of health significance. (4 q.h.)

ENV 551 Introduction to Air Pollution - Principal types, sources, dispersion, effects and physical, economic and legal aspects of control of atmospheric pollutants. (4 q.h.)

ENV 560 Ecological and General Systems - Systems ecology including examples, languages, theoretical formulations, and models for design, synthesis, and prediction of systems of man and nature. (4 q.h.)

ENV 561 Ecological Engineering Seminar - Principles of environmental design and means for guiding self-design of systems of nature and man, including review of manageable ecological systems, regional patterns, technological interfaces, new approaches, and literature. (2 q.h.)

ENV 591 Special Topics in Environmental Engineering - Laboratory, lectures or conferences covering specially selected topics in environmental engineering. (1-5 q.h.)

ENV 613 Environmental Resource Systems - Standards and criteria for evaluation of environmental resource projects. Formulation of mathematical models of environmental problems. Application of systems engineering and operations research as aids in decision-making. (4 q.h.)

ENV 616 Urban Environmental Problems - Examination of the overall problem of developing and maintaining a high quality physical environment in urban areas. A systems analysis approach to air, and water quality management problems is discussed. (4 q.h.)

ENV 618 Pollution Transport Systems - Distribution of pollutants in natural waters and the atmosphere. Diffusive and advective transport phenomena. (4 q.h.)

ENV 630 Environmental Chemistry - Water treatment, chemical composition of natural waters and other phases of environmental chemistry. Applications of physical and organic chemistry of aqueous and gaseous systems. (1-5 q.h.)

ENV 650 Occupational Health - Effects, assessment and control of physical and chemical factors in the working environment, including chemical agents, electromagnetic radiation, temperature, humidity, pressures, illumination, noise and vibration. (4 q.h.)

ENV 652 Environmental Instrumentation - Basic instrumentation and instrumental techniques for the measurement of environmental parameters and pollutants. (5 q.h.)

ENV 653 Aerosol Mechanics - Generation, collection and measurement of aerosols, theory of the fluid dynamic, optical, electrical, and thermal behavior of gas borne particles. (4 q.h.)

ENV 654 Air Pollution Sampling and Analysis - Determination of concentration of normally encountered ambient pollutants. Methodology

ENV 654 (Cont'd) - of source sampling. Practical experience in ambient and source sampling. (4 q.h.)

ENV 655 Air Pollution Control Measures - Design, analysis, operational limitations, cost and performance evaluation of air pollution control processes and equipment. Field visits to and inspections of industrial installations. (4 q.h.)

ENV 656 Environmental Meteorology - Dynamics and thermodynamics of the atmosphere relative to environmental problems. Analysis of weather charts. Numerical weather prediction models. (4 q.h.)

ENV 657 Environmental Micrometeorology - Prediction of down wind pollutant concentrations from point, line and area sources. Theory of turbulence and phenomena related to problems in diffusion and dispersion of contaminants in the lowest layer of the atmosphere. (4 q.h.)

ENV 668 Health Hazards of Man's Environment - Environmental factors which adversely affect man's well being are related to epidemiology and human physiology. (4 q.h.)

INSTITUTION: UNIVERSITY OF IOWA (UI)

PROGRAM: Environmental Engineering

DEPARTMENT: Division of Energy Engineering

DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Richard R. Dague
2216 Engineering Building
University of Iowa
Iowa City, Iowa 52242
(319) 353-3388

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The program began in 1927, offering a degree in "sanitary engineering". Until 1968 students with a B.S. engineering background were the only ones admitted to the graduate program. Since that time, a second option (undergraduate degrees in a basic science area) has become available. The degrees must have a major in one of the physical, chemical, biological or mathematical sciences. Two of the eight major areas of study (environmental, mechanics and hydraulics) at the UI's College of Engineering offer degrees at only the graduate level.

Programs of study are designed to develop a high level of competence in water quality, air quality, solid wastes management, or general. Sixteen to eighteen hours are required in each speciality area.

PROGRAM REQUIREMENTS

Minimum undergraduate grade-point average (GPA) is 2.5 for admission to the Masters program. A non-thesis plan of study requires 33 credit hours and 3 credits for a major report; thesis - 24 credit hours and 6 hours of research.

Ph.D. admission requires a Master's degree with a thesis in either engineering or basic science; GPA is 3.2 on previous graduate work. A minimum of 72 semester hours of credit beyond the basis undergraduate degree is required. Eighteen of these hours may be applied to thesis research. A one year on-campus residency is also required.

Core courses vary for the student coming into the program with the applied science or engineering background. Prospective students should contact the department for more detailed information. Elective courses are permitted to complete the program if approved by the student's advisory committee (3 members for Masters and 5 for Ph.D.).

CURRENT FACULTY, STUDENTS, GRADUATES

Weekly seminars are held for environmental engineering students. Speakers are graduate students, professors or outside professionals. Some topics covered in the Fall of 1977 were "Trends in Energy Development", "Lake Erie: Is It Really Dead or Does It Always Smell That Way?", Pesticide Interactions in Iowa Rivers or Betcha Shouldn't Eat Just One (Fish)".

Students are taken on major field trips to Chicago, Minneapolis or St. Louis, in-state field trips and national meeting yearly. Most expenses for these trips/meetings are assumed by the department.

Laboratory facilities and office space for students engaged primarily in wastewater treatment research are located at the Philip F. Morgan Research Laboratory. This facility is located on the grounds of the Iowa City municipal wastewater treatment plant, an 8 mgd treatment facility. The "Morgan Lab" contains 2,000 square feet of space devoted to a wet-chemistry laboratory and areas for bench and pilot scale studies. The lab also contains a full-scale section of an aeration tank with a volume of 10,000 gallons.

The 4 mgd University Water Treatment Plant provides 4,500 square feet of laboratory and office space. The "Water Plant" lab is fully equipped for both the routine and advanced chemical and biological analyses of water. The water plant facility is unique in that the plant is designed not only to produce a potable water for the University community, but also to allow the full scale study of specific unit operations and processes.

Present enrollment in the Ph.D. program is five; 27 full-time and 25 part-time in the M.S. Graduates number 15--one Ph.D. and 14 Masters. Financial aid is available through research assistantships, fellowships, contracts with private industry and grants.

Six faculty engage in research and teaching on a full-time basis. Five others hold joint appointments or routinely participate in the department activities. Research has been funded by and conducted for the Department of Energy and a number of private industrial clients.

PROGRAM PROJECTIONS

The long-range goals and objectives of the program are to expand, attracting and graduating more students.

ADDITIONAL INFORMATION

The Iowa Institute of Hydraulic Research was founded in 1920 and now deals with a host of problems ranging from the dispersion of thermal and other pollutants in air and water to the movement of ships through ice-covered waters and super-sonic aircraft through the air. The Environmental Engineering Program works closely with the Institute of Hydraulic Research on many research projects and contract studies. Similar working relationships are maintained with the Institute of Agricultural Medicine and Environmental Health and the Institute of Urban and Regional Research, also on the University of Iowa campus.

A 40 hour workshop that taught the techniques of value analysis with special emphasis on the requirements of the EPA's mandatory VE study in Step II Program was held in June, 1977. The title was "Environmental Specialty Workshop on Value Engineering in Wastewater Treatment Plant Design". It was sponsored by UI's College of Engineering in cooperation with the Iowa Section, American Society of Civil Engineers and Consulting Engineers Council of Iowa.

The College of Engineering and Iowa State University, in cooperation with Iowa Department of Environmental Quality, Iowa Water Pollution Control Association and Iowa Section American Water Works Association sponsored the Eleventh Advanced Water and Wastewater Works Operators Education Course in November, 1977.

COURSE DESCRIPTION (A partial listing)

General Courses: 527:104 Environmental Planning and Assessment - Planning for and the assessment of the environmental impacts of man-made systems, including transportation, water resource, power generation, housing and other facilities. (2 s.h.)

Environmental Sciences: 523:150 Principles of Environmental Engineering - Physical, chemical and biological principles of water and wastewater treatment, air pollution control and solid wastes management. (3 s.h.)

523:151 Hydraulic Systems Design in Environmental Engineering - Application of hydraulic principles to the design of transport systems in environmental engineering with emphasis on water transmission and wastewater and storm water collection and treatment systems. (3 s.h.)

524:152 Environmental Chemistry - Principles of general, qualitative, organic and physical chemistry applied in water and air systems. (3 s.h.)

524:153 Environmental Chemistry Laboratory - Laboratory procedures in the routine physical, chemical and biological analysis of water, wastewater and solid wastes. (2 s.h.)

524:154 Environmental Microbiology - Fundamentals of microbiology with applications in water quality and wastewater treatment systems. (3 s.h.)

524:155 Limnology - Physical, chemical and biological characteristics of natural waters with emphasis on the relationships between the biota and the physiochemical aspects of the aquatic environment. (2-3 s.h.)

524:156 Environmental Operations and Processes - Theory of physical, chemical and biological unit operations and processes in water and wastewater treatment. (3 s.h.)

524:157 Environmental Engineering Design - Practical aspects of the design of water and wastewater treatment systems. (3 s.h.)

524:158 Air Pollution and Solid Wastes - Sources, characteristics and effects on environmental quality of air pollutants and solid wastes. Analysis and design of control systems, including the recovery of resources from solid wastes. (3 s.h.)

522:159 Meteorological Aspects of Air Pollution - Selected topics in meteorology and climatology, particularly those affecting transport, dispersion and modification of pollutants; impact on community planning and plant design. (2 s.h.)

528:160 Air Pollution and Control Technology - Air pollution causes and effects; diffusion through the atmosphere with meteorological, climatological and topographical effects; chemical reactions and natural cleansing mechanisms; concepts in control technology. (3 s.h.)

524:250 Water Quality - Design of advanced water and wastewater treatment systems. Topics include the application of physical, chemical and biological processes to the removal of nitrogen, phosphorus, dissolved solids and refractory compounds from water and wastewater and the application of wastewater liquids and sludges to land. (2 s.h.)

524:251 Environmental Systems Modeling - The mathematical modeling of environmental processes, including aquatic, atmospheric, terrestrial and treatment systems. Study, analysis and application of existing models. (2 s.h.)

524:252 Advanced Environmental Chemistry - Lectures and laboratory dealing with advanced concepts and instrumental methods in the analysis of water, wastewater, air and solid wastes. (3 s.h.)

524:254 Environmental Toxicology - The nature and sources of toxic substances in the environment and their metabolic and ecological effects on humans and other living forms. (2 s.h.)

524:256 Environmental Systems Laboratory - Laboratory evaluation and discussion of the unit operations and processes in water and wastewater treatment with emphasis on the interpretation of theoretical concepts in full-scale systems. (3 s.h.)

524:257 Industrial Water Quality Control - Quantity, quality and treatment of various industrial process waters. Sources, characteristics and treatment of industrial wastewaters to meet effluent standards and requirements for multiple use and re-use. (3 s.h.)

524:258 Solid Wastes Technology - Analysis and design of solid wastes management systems, including collection and processing by shredding, bailing, incineration, pyrolysis and biological stabilization. Ultimate disposal by landfilling. (3 s.h.)

Fluid Mechanics: 523:065 Flow Systems in Environmental Engineering - Application of the principles of hydrology and hydraulics to the analysis and design of water and wastewater transfer systems. (3 s.h.)

INSTITUTION: UNIVERSITY OF KENTUCKY

PROGRAM: Environmental Engineering

DEPARTMENT: Chemical Engineering

DEGREE: Master of Science (M.S.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Robert Grieves, Chairman
Department of Chemical Engineering
University of Kentucky
Lexington, Kentucky 40506
(606) 257-1748

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Chemical Engineering began with the Bachelor of Science degree in 1957. The M.S. followed it in 1967, the year the B.S. became accredited by the Engineers' Council for Professional Development (ECPD); the Ph.D. began in 1969.

Students have several options for specialization; they may elect a conventional chemical engineering curriculum, one in energy engineering[1], or one in environmental engineering. A concentration in environmental engineering will allow a further specialization in air pollution control, water pollution control, or a combination of the two. In the past there existed an EPA-funded M.S. in Air Pollution Control program. Only one student is still involved in this program, and when he graduates the air pollution option may be included in the environmental engineering concentration.

Graduates of the environmental option are in demand by industry, with credentials and capability as environmental engineers and as chemical engineers. They are recruited by pollution control equipment and process companies; by petroleum, chemical and pharmaceutical companies as part of environmental teams; and by specialized companies as pollution engineers. They are valuable to consulting engineering firms specializing in industrial problems. In federal, state, or municipal government, they are uniquely skilled to communicate with chemical engineers in industries which have pollution problems, and to read and interpret plans for new equipment and processes requiring governmental permits.

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[1] A separate description of the energy engineering program is in the Energy volume of this report.

Approximately one-half of the space which this department occupies is devoted to experimental graduate research. Analytical instruments such as IR (infra-red) and UV (ultra-violet) spectrophotometers, an automatic carbon analyzer, several gas chromatographs, a low-temperature asher, a surface area analyzer, and an atomic absorption spectrophotometer are available and operated exclusively by the department. Other more sophisticated instruments are available upon request in other departments. The Engineering Library is located in the same building as the department, and the computer center is adjacent to it. The Water Resources Research Institute (WRRI) is directed by the chairman of the Chemical Engineering Department, and provides research topics in a full range of environmental areas, with several departments involved.

PROGRAM REQUIREMENTS

Students who wish to enter the M.S. program should have taken the Graduate Records Examination; have undergraduate degrees from appropriate ECPD-accredited programs or the equivalent; have satisfactory academic records; and letters of recommendation.

The basic program consists of eight three-semester-credit courses, in addition to a suitable M.S. thesis on an environmental engineering topic. For students with extensive experience in the pollution field, the thesis can be waived and replaced with two additional courses. Considerable flexibility exists in the selection of courses and the thesis topic.

In addition to this M.S. specialization, unique and individualized programs can be designed for the student wishing to pursue a Ph.D. degree with specialization in environmental pollution control. Historically, thirteen Ph.D. degrees have been awarded in chemical engineering.[2]

The candidate for the Ph.D. is usually required to devote no fewer than three years (beyond the B.S. degree) of graduate study to the broad field of chemical engineering, present a satisfactory thesis, and pass a comprehensive examination on his/her thesis subject and chosen field. There is no stipulated number of courses which the Ph.D. student must complete; rather, an individualized program is designed for each student with his/her thesis advisory committee. In order to enable scientific literacy, each student is required to pass a reading examination or a special course in scientific French, German, or Russian.

The environmental programs are unique in that they are strongly oriented to the chemical engineering field, and too because of the broad range of topics available for thesis research. Particular areas are modeling of atmospheric dispersion, aerosol behavior, industrial waste treatment, and physico-chemical separations applied to specific water pollutants.

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[2] Not limited to the environmental engineering option.

CURRENT FACULTY, STUDENTS, GRADUATES

There are ten full-time faculty in chemical engineering; all ten have Ph.D.'s and nine are tenured. A distribution breakdown of departmental efforts is as follows: instruction, 47 percent; administration, 10 percent; professional activities, 10 percent; and research, 33 percent.

In the fall of 1977, there were twenty full-time and five part-time graduate students. Six of these people opted for concentrations in environmental engineering, ten for energy engineering, and the remainder in classical chemical engineering. All of the full-time students are receiving financial aid in the form of graduate fellowships with no teaching or research duties. Most of the students did not do their undergraduate work at the University of Kentucky.

The number of M.S. graduates in 1977 was down slightly from previous years. The average for the five years previous to 1977 was thirteen and in 1977 there were nine.[3]

The campus placement service has been a very effective agent in helping graduates find employment in chemical engineering, just as the professional contacts made by faculty members have been. A follow-up survey traced the employment history of each of the sixty-nine advanced degree graduates in chemical engineering. Thirty-six took positions with industry, twelve accepted governmental jobs (three with the Environmental Protection Agency, one with the Tennessee Valley Authority, and eight with state environmental agencies), six continued their educations, three accepted teaching positions at universities or colleges, two were employed by consulting firms, three were employed by utilities, and two were employed by research institutes.

It is valuable for the graduates in some instances to become certified as Professional Engineers. This registration is on a state-by-state basis, but basically the procedure for each is constant. Upon graduation, a state board examination is conducted at which time those who have passed will receive a training engineer certificate. After five years of practice, a Professional Engineer status is registered. Thirty to forty percent of all chemical engineering graduates will take the examination.

PROGRAM PROJECTIONS

There is a need to establish external funding for environmental engineering specializations. While diversifying the specialties offered in this specialization is an attractive concept, it is not economically feasible at this time. For the time being the plans for this option involve increasing the enrollment slightly and maintaining the current offerings.

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[3] Not exclusively environmental engineering.

ADDITIONAL INFORMATION

In the past there was an M.S. Training Program in Air Pollution Control offered. This option was first funded by the Division of Air Pollution Control of the Public Health Service (now the Environmental Protection Agency) in 1968. Total training money between 1968 and 1977 amounted to approximately $400,000. Nearly all of this money went to M.S. student traineeships. Many of the graduates went to work in the state agencies. There has been no new money available for this training program since 1975, so students have realigned their interests to funded programs. While an air pollution option is offered through the environmental concentration, it has a somewhat different thrust than the M.S. in Air Pollution Control did. It was mentioned previously that one student is still in this degree option, but with his graduation this option may be terminated.

COURSE DESCRIPTION

CME 505 Analysis of Chemical Engineering Problems - Application of numerical methods, differential equations, and transforms to complex chemical engineering problems. (3 s.h.)

CME 515 Air Pollution Control - Kinetics and equilibria of photochemical and "dark" atmospheric reactions. Atmospheric statics and dynamics including lapse rates, inversions, and vertical and horizontal air motion. Single and area source diffusion. (3 s.h.)

CME 565 Energy Engineering - Energy supply and demand, material and energy balances for fossil fuel to fuel conversion including thermodynamic considerations, analysis of electrical power generation by conventional methods and by potential methods. (3 s.h.)

CME 580 Design of Rate and Equilibrium Processes for Water Pollution Control - Design of chemical and physical processes for the removal and concentration of organic, inorganic, and particulate pollutants from aqueous solution/suspension; absorption, destabilization, disinfection, membrane processes, thermal processes, flow through beds of solids, etc. (3 s.h.)

CME 615 Advanced Air Pollution Control - Principles and techniques of control of atmospheric pollution, including process design for the removal of gaseous and particulate pollutants from air streams. Legal and administrative aspects of control. (3 s.h.)

CME 617 Air Sampling and Analysis - Theory and techniques of air sampling, including aerosol sampling. Instrumental, gravimetric, and volumetric analysis of gaseous and particulate air pollutants with emphasis on modern methods of instrumental analysis. (3 s.h.)

CME 619 Community Health Aspects of Air Pollution Control - Effects of specified pollutants on humans, materials, and the environment. Solid waste disposal by incineration. Air pollution control and water pollution control interrelationships. (3 s.h.)

CE 663 Water Quality Control Laboratory II - Laboratory scale studies and evaluations of water pollution control processes and techniques. (3 s.h.)

CE 669 Water Quality in Surface Waters - Analysis of dispersion, advection, evaporation, natural aeration, biological oxidation, and photosynthesis; their effects on the physical, chemical, and biological quality of waters in streams, lakes, etc. Eutrophication. Water quality requirements. (3 s.h.)

CME 680 Biochemical Engineering - Principles and design processes involving bio-chemical reactions, including aerobic and anaerobic respirations and fermentations, and involving pure and mixed cultures. Energy considerations, heat and mass transfer, biochemical kinetics, and application to biological waste treatment. (3 s.h.)

INSTITUTION: UNIVERSITY OF MARYLAND

PROGRAM: Environmental Engineering
DEPARTMENT: Civil Engineering
DEGREE: Master of Science (M.S.)

CONTACT: Dr. Robert M. Ragan
Chairman, Civil Engineering
University of Maryland
College Park, Maryland 20742

(301) 454-2438

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Organized in 1972, the program emphasizes learning sound engineering principles and their application to meet the needs of man. All programs are planned on an individual basis between the student and his advisor, with consideration to the student's background and special interests. The program prepares its students to become Watershed Engineers, Consulting Engineers, and Resource Managers primarily at the state level.

The department conducts workshops for engineers in practice, and seminars for students and engineers in the vicinity. It also provides a seminar program intended to alleviate the problem of current graduates who lack communication skills. Various research and support facilities are made available to the students, including a Chemical Process Laboratory, Air Pollution Laboratory, Fluid Mechanics Lab, Computer Simulation Lab, and a Remote Sensing Laboratory.

PROGRAM REQUIREMENTS

Students entering this program must hold a B.S. degree in Civil Engineering. Students with other degrees may enter the program providing that they agree to correct any deficiencies in their course work before enrolling in graduate courses. There are no examinations required prior to entering the program.

The program includes twelve hours of course work in the major subject area and twelve hours of course work at the 600 level or higher. The student may choose either the thesis or non-thesis option. The The thesis requires twenty-four credit hours plus a thesis, and the latter requires thirty hours of course work. Those choosing the non-thesis option must submit one or more scholarly and pass a written comprehensive examination. Additional courses may be required if the student is not adequately prepared for required courses. The student must have an over-all 'B' average in order to graduate, and all requirements must be completed within a five-year period.

CURRENT FACULTY, STUDENTS, GRADUATES

There are currently six faculty members, all doing research and teaching. The program plans to increase its staff by one Ph.D. in the area of Biological Treatment Processes and one Ph.D. in the area of Unit Operations within the next five years. Research funding available comes from the State Department, NASA, EPA stipends, NSF, Department of Interior, the Department of Agriculture, the Agency for International Development, the Minta Martin Foundation, and the Department of Transportation. In previous years, the department received EPA training grants.

Two full-time females and sixteen full-time males are currently enrolled in the program. Enrolled on a part-time basis are seventeen males and one female. Enrollment in the program is considered small in comparison to other programs within the University. The program is comprised of nearly fifty percent "career change" students.

There are approximately seven or eight graduates per year. One-hundred percent of the graduates find employment in their field, forty percent in the government and sixty percent privately. For the most part, students find employment through their own efforts, though some use referrals from staff members.

PROGRAM PROJECTIONS

The department plans to expand the program over the next four years. Student enrollment should expand by twenty percent and the staff should increase by two. The program does not plan to develop any new programs leading to different degrees, yet they would like to develop new course work within the present program that would provide training in the application of satellite remote sensing to environmental problems, as this is currently being used in industry.

COURSE DESCRIPTION

Graduate Courses:

ENCE 410 Advanced Strength of Materials - Strength and deformation of deformable bodies, plane stress and strain. (3 s.h.)

ENCE 434 Air Pollution - Classification of atmospheric pollutants and their effects on visibility, inanimate and animate receptors. Evaluation of source emissions and principles of air pollution control; meteorological factors governing the distribution and removal of air pollutants; air quality measurements and air pollution control legislation. (3 s.h.)

ENCE 633 The Chemistry of Natural Waters - Application of principles from chemical thermodynamics and kinetics to the study and interpretation of the chemical characteristics of natural water systems. The chemical composition of natural water is rationalized by considering metal ion soluability controls which occur in natural water environments. (4 s.h.)

ENCE 634 Air Sampling and Analysis - The theory and techniques used in the determination and measurement of chemical, radiological, and biological pollutants in the atmosphere. Discussion of air sampling equipment, analytical methods and data evaluation. (3 s.h.)

ENCE 733 Applied Water Chemistry - A study of the chemistry of both municipal and industrial water treatment processes. Among the topics to be considered are water softening, stabilization, chemical destabilization of colloidal materials, ion exchange, disinfection, chemical oxidation and oxygenation reactions. (4 s.h.)

ENCE 735 Design of Municipal and Industrial Wastes Treatment Facilities - Application of basic science and engineering science to design of municipal and industrial waste treatment processes; design and economics of unit operations as applied to environmental systems. (3 s.h.)

ENCE 736 Theory of Aqueous and Solid Waste Treatment and Disposal - Theory and basic principles of treating and handling waste products; hydraulics of sewers; biological oxidation; principles and design criteria of biological and physical treatment processes; disposal of waste sludges and solids. (3.s.h.)

ENCE 737 Industrial Wastes - A study of the characteristics of liquid wastes from major industries, and the processes producing the wastes. The theory and methods of eliminating or treating the wastes and their effects upon municipal sewage-treatment plants, and receiving waters. (3 s.h.)

INSTITUTION: UNIVERSITY OF MICHIGAN

PROGRAM: Industrial Hygiene and Air Pollution

DEPARTMENT: Environmental and Industrial Health

DEGREE: Master of Public Health (M.P.H.)
Master of Science in Industrial Health (M.S.)
Doctor of Public Health (Dr. P.H.)
Doctor of Philosophy in Industrial Health (Ph.D.)

CONTACT: Dr. Dohrman H. Byers
Department of Environmental and Industrial Health
School of Public Health
University of Michigan
Ann Arbor, Michigan 48104
(313) 764-2594

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

While the programs in Industrial Hygiene and Air Pollution at the University of Michigan both examine the human exposure to contaminants, the former course of study emphasizes the industrial worker's occupational environment while the latter focuses on the general population's total daily exposure to air pollution. Students in Industrial Hygiene are trained in the recognition, measurement, evaluation, and control of occupational exposures to chemical and physical hazards. Courses cover sources of exposure, toxicity of materials, effects of physical agencies, application of legal and professional standards, and engineering and administrative methods of achieving safe working conditions. Students seeking degrees with emphasis in air pollution concentrate their studies in the investigation, evaluation, and control of community air pollution problems; their courses outline sources, nature, properties, and effects of pollutants as well as the patterns of pollution and the engineering and other methods of controlling these.

The applied-science training offered through either the Industrial Hygiene or Air Pollution areas of concentration is characteristically general--specialization within each field comes with one's job experience. All students complete a field course on in-plant studies in which students visit 8-10 industries for one day each and identify the industrial health measures which must be taken to insure occupational safety.

Research in the department includes a contract with the Chlorine Institute and a ventilation study for a private company. The staff recently completed a six-criteria documant for the National Institute for Occupational Safety and Health. Additional funding from industry helps to support student research. The facilities for teaching and research total eight well-equipped laboratories and basic field instrumentation. The department conducts a number of workshops and short courses for industrial and government agency personnel; these include a NIOSH-AIHA sponsored five-day course for non-professional management people to acquaint them with the field and meetings of 30-50 industrial hygienists and industrial physicians from major corporations to discuss mutual problems.

PROGRAM REQUIREMENTS

The Master of Public Health degree (M.P.H.) requires enrollment in the School of Public Health. The course of study may vary from 36 credit hours to 60 credit hours, depending on prior experience and preparation; this represents from two and one-half to five terms as a full-time student at the school. Two or more years of experience in a health-related field subsequent to completion of the bachelor's degree is required for admission to the minimum 36 hour degree program. For students with no prior acceptable experience, the 60 hour degree program is required. For intermediate experience some adjustment in requirements may be made. All students in degree programs in the School of Public Health are required to complete the "core course", which is a series of courses designed to give a basic knowledge of public health methods and practices as well as an overview of the comprehensive aspects of this professional field.

The M.S. degree in Industrial Health allows the student to elect study in industrial hygiene or air pollution. The actual course of study is supervised in the School of Public Health and is comprised of most of the same courses as for the M.P.H. There is no experience requirement for the M.S. program. The student must complete 36 credit hours which usually take two and one-half to three terms. The Public Health "core course" is not required but equivalent study in biostatistics and epidemiology usually is required.

The Doctor of Public Health (Dr. P.H.) and the Doctor of Philosophy (Ph.D.) in the fields of industrial hygiene and air pollution share essentially the same requirements. The master's degree is not required, but all requirements of that degree must be fulfilled to qualify as a doctoral candidate. Students must complete a research project and prepare and defend an acceptable dissertation. The doctoral degrees usually take about three years beyond the master's requirements.

Applicants for any of the above degrees must have completed a bachelor's degree from an acceptable school (3.0 GPA requirement unless special ability or circumstance). A science background is desirable including a course in college-level mathematics, physics, and chemistry (analytical and organic). Some biological science study is helpful.

CURRENT FACULTY, STUDENTS, GRADUATES

There are three full-time faculty in Air Pollution and Industrial Hygiene; but faculty from other areas in the Environmental and Industrial Health department and other departments teach courses in epidemiology, biostatistics, bioengineering, toxicology,, computer technology, radiological health, and water quality. Of the forty-five full-time students in Industrial Hygiene, ten are doctoral candidates. Enrollemnt in Air Pollution is drastically low -- one M.S. and one Ph.D. student. The program growth in Industrial Hygiene due to legislation and job opportunities stands in sharp contrast to the decline in the Air Pollution area due to minimal availability of student financial aid. The program graduates an average of twenty students annually with yearly fluctuations attributed to the one-year time frame taken by M.S. students compared with the two-year residence required to complete the M.P.H. The number of graduates is increasing slightly despite the University's "no-growth" policy for achieving optimum levels for facilities, student-faculty ratios, and overall quality, not quantity.

Virtually all students are employed in the field with 90 percent taking jobs in the private sector. Salary inequities between government and private-sector positions have contributed to a growing shift away from public jobs, except for those students with a "social conscience", according to department personnel. Employment opportunities exist in government at all levels, industries with air pollution problems, consulting firms, and universities. Financial assistance to 15-16 students comes mostly from a NIOSH training grant, and some from industrial grants, the Environmental Protection Agency, and the university.

PROGRAM PROJECTIONS

Manpower needs in Industrial Hygiene will assure the employability of graduates with this specialization for the next decade or so. The Department is presently searching for two additional faculty-- one engineer or chemist for Industrial Hygiene/Air Pollution and one physician (M.D.) for Occupational Medicine. The increase in non-medical faculty from three to four has been approved. To comply more nearly with school policy, the program will be limiting enrollment to a total of about 35 and scaling down present levels over a two-year period. No major curriculum changes are expected.

COURSE DESCRIPTION

Environmental and Industrial Health courses:

500 Environment and Health - Environmental factors affecting health and disease and major related principles of sanitary science employed in modification of the environment for the promotion of health. Primarily for students other than those majoring in environmental health. (2 s.h.)

501 Environmental Physiology - The effect of environmental stresses on human physiology. Mechanism of production of disease through toxic materials in air, food, and water. Physical variants of temperature, air pressure, electromagnetic energy, and vibration in the production of disease states. (2 s.h.)

502 Principles of Environmental Health - Principles of engineering and science used in the control of man's environment. Includes water supply and treatment, sewerage, wastewater treatment, plumbing and cross connections, swimming pools and bathing areas, refuse collection and disposal, industrial hygiene, ventilation, noise, illumination, community air pollution, radiological health principles, food and milk sanitation, insect and rodent control, housing. (3 s.h.)

504 Computer Applications in Environmental Health - Introduction to data processing, information storage and retrieval systems, and computer programming of environmental health problems.

508 Radiation in the Environment - The biological effects of radiation as a basis for radiation protection standards. Principles and methods of protection against radiation hazards, with emphasis on natural and man-made sources of radioactivity. A comparison of radiation with other toxic agents in the environment. (2 s.h.)

511 Equipment Sanitation Standards, Design, and Evaluation - Principles of sanitation and design, selection of materials, and construction of equipment, such as employed in processing, vending, and dispensing of food; swimming pools and other installations; technical methods of evaluation--bacteriological, physical, chemical, thermodynamic, radioactive, hydraulic; development, implementation, and administration of national standards for industry and local and state regulatory agencies.

512 Environmental Health Administration Practice - Modern concepts, scope, and objectives of environmental health practice. Responsibilities of personnel. Determination of community environmental health problems and needs. Program planning, emphasis, and evaluation. Principles, content, methods, and tools. (2 s.h.)

513 Advanced Environmental Health Administrative Practice - Administration of environmental health programs and organizations. Organizational structure, forces of management, administrative controls, personnel and financial management, legal aspects. (2 s.h.)

517 Environmental Health in Developing Areas - Designed primarily to give individual attention to small groups of foreign students with specific problems in the technical and administrative practices of environmental health. (2 s.h.)

521 Environmental Planning - Constructs an analytic framework within which environmental (health) policy and planning are evaluated. Emphasis on the design and concept of social cost and pollution damage functions and their economic, social, and health implications. (3 s.h.)

531 Environmental Chemistry - Integration of selected principles in physical, organic, and biological chemistry to the study and control of the human environment. Emphasis to demonstrate the underlying difference and unity among various environmental phenomena. (3 s.h.)

533 Fundamentals of Instrumental Methods of Chemical Analysis - Fundamental principles, operation, application of modern instruments in scientific analysis. Instruments include emission, ultraviolet and infrared spectroscopy, X-ray emission and diffraction, gas chromatography, mass spectroscopy, and others. Emphasis on application to environmental and medical fields. (3 s.h.)

541 Essentials of Toxicology - Biological response of man and experimental animals to toxic compounds and factors which influence this response. Detoxication mechanisms. The toxicity of selected groups of chemical compounds. (2 s.h.)

542 Industrial Toxicology - Continuation of EIH 541. Topics include mechanisms of selective toxicity, toxicity and metabolism of aromatic compounds. The relationship of chemical structure to biological activity. (2 s.h.)

543 Ecological Toxicology - Dynamics of toxic substances in the environment. The effects of toxic substances on individuals, populations, and communities of organisms presented in an ecological context. (3 s.h.)

544 Methods in Toxicology - Methods of evaluating acute and chronic toxicity of solids, liquids, and vapors. Techniques of establishing controlled exposures to toxic materials. Directed individual investigations of the toxicity of assigned materials. (3 s.h.)

551 Principles and methods of Industrial Health - Organization of industrial health services in government and in industry. Public health approach to industry. Representative industrial health situations. For public health administrators, sanitary engineers, sanitarians, nurses, educators, and others. Primarily for students not specializing in industrial health. (2 s.h.)

560 Principles of Community Air Pollution - Discussion of economic, nuisance, and health aspects, emphasizing sources, causes, effects, control measures, and the organization and administration of community control programs. (3 s.h.)

561 Health Factors in Air Pollution - Acquaints the student with relationships and applications of physiology, toxicology, epidemiology, bacteriology, and radiation to the field of air pollution. (3 s.h.)

606 Environmental Health Seminar - Seminar reading and discussion in the broad and specialized areas of environmental health. (1-2 s.h.)

650 Industrial Hygiene - Basic concepts of industrial hygiene and occupational health hazards. Physical and chemical stresses of the industrial environment; sources; effects, measurement, evaluation, and control of exposure. (3 s.h.)

651 Industrial Hygiene Control - Control methods other than ventilation for conservation of industrial health, such as substitution and personal protection, with reference to special operations and industries. (2 s.h.)

652 Air Sampling and Analysis - Laboratory and field methods and equipment for appraisal of occupational environmental conditions. Such procedures are related to dusts, fumes, vapors, gases, mists, noise, odors, illumination, temperatures, and humidity. (2 s.h.)

653 Industrial Hygiene Sampling and Analysis - A continuation of EIH 652 with inclusion of analysis of biological specimens. (2 s.h.)

654 Ventilation Control of Contaminants - Industrial ventilation as related to needs of the industrial hygiene engineer, including principles of air flow, natural and power ventilation, supply and exhaust, characteristics and design of exhaust hoods, ventilation of specific processes, design of systems, fans, collectors, testing instruments. Lectures, recitation, problems, and experiences with use of instruments. (3 s.h.)

655 Industrial Safety - Safety considerations in the design of industrial machines and processes. Current safety laws. Recommended industry design standards. Management of risks. Accident investigation and analysis techniques. Relation of safety designs to production efficiency. Measures of accident frequency and severity. Current occupational safety research. (3 s.h.)

656 Industrial Health Seminar - Special case study assignments and discussions on selected health subjects involving hazards of work environment and their evaluation and control. (2 s.h.)

658 Physical Stress in the Environment - Basic concepts of recognizing, evaluating, and controlling physical stress in the environment with emphasis on occupational exposures. Topics include: heat stress, illumination, ultraviolet and infrared energy, microwaves, lasers, and noise and vibration (emphasis). (2 s.h.)

659 In-Plant Studies - Practicum experience centered around trips to industries (8-10) and evaluation of industrial hygiene problems and solutions. (2 s.h.)

660 Sampling Methods in Air Pollution - Familiarizes the student with various instruments and techniques for determining amount and nature of air pollutants in stacks and in the community, together with application of these methods. (3 s.h.)

662 Air Pollution Seminar - Special assignments concerning evaluation and control of air pollution problems. Second term (EIH 663) is a continuation of first term. (2 s.h.)

665 Analysis of Air Pollutants - Principles and methods of operating automatic field and laboratory instruments and of chemical analyses of air pollutants; laboratory exercises using representative instrumentation and selected analytical methods. (3 s.h.)

666 Air Pollution Chemistry - Second half, E.H.: the physical-chemical theory, and application of analytical processes for the determination of air pollutants and their reactions in the natural environment. Systems for the analysis of trace metals and organics. Theory of interaction in light and air pollutant molecules for continuous monitoring. (3 s.h.)

862 Advanced Seminar in Air Pollution - Assignments in depth of problems associated with air pollution. Selected guest discussion leaders. For pre-doctoral students. (1-2 s.h.)

INSTITUTION: UNIVERSITY OF MISSOURI-ROLLA (UMR)

PROGRAM: Environmental and Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Civil Engineering (M.S.)
Doctorate in Civil Engineering (Ph.D.)

CONTACT: Dr. J. H. Senne, Chairman
Department of Civil Engineering
University of Missouri-Rolla
Rolla, Missouri 65401
(314) 341-4461

Dr. Ju-Chang Huang, Area Head
Environmental & Sanitary
Engineering Program
Department of Civil Engineering
University of Missouri-Rolla
Rolla, Missouri 65401
(314)341-4461

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

This program is administered by the Department of Civil Engineering and is open to qualified students in engineering and related physical and life sciences. It offers a strong and well rounded curriculum consisting of graduate training and research in the areas of water and wastewater engineering, air pollution control, and solid waste management. It is well supported with departmental offerings in other areas, primarily water resources engineering, hydrology and hydraulic engineering, environmental and planning engineering; complemented with courses in other engineering and science disciplines; and strengthened by a strong and expanding research program.

PROGRAM REQUIREMENTS

Graduate study in environmental and sanitary engineering usually leads to the Master of Science and Doctor of Philosophy degrees in Civil Engineering. There are two programs available to the students at the master's level; the first requires a minimum of 30 semester credit hours and the preparation of a research thesis, while the second is a non-thesis degree requiring at least 33 semester credit hours. In both cases at least six semester hours must be taken outside the Civil Engineering Department. Most students undertake the thesis option. Depending upon their background and experience, students who have not received their undergraduate training in civil engineering might be required to take deficiency undergraduate work in water and wastewater engineering in order to better prepare themselves for the graduate program.

Beginning with the Fall 1971 semester a program has been offered at the UMR St. Louis Graduate Engineering Center, and today approximately 35 practicing engineers and scientists from the Greater St. Louis area are pursuing graduate study leading to the M.S. degree on a part-time basis.

Graduate course offerings include water and wastewater engineering, air and water resources, solid waste management, and a selected group of supporting courses in engineering and science. Each student formulates with the advice and consent of his advisor, an individual program of graduate study and research which is best adapted to his own interest and preparation. While considerable emphasis is given to basic sciences and fundamental concepts so necessary for understanding sanitary engineering processes and operations, the main thrust is toward engineering.

CURRENT FACULTY, STUDENTS, GRADUATES

The faculty consists of seven full-time professors under the direction of a program area head. Four professors and the area head are Professional Engineers.

Currently, eleven men and two women are enrolled full-time in the masters program; there is one doctoral student. The program offers off campus courses in St. Louis; 45 persons are enrolled as part-time masters students in St. Louis.

Graduates have little difficulty finding employment. They often have several offers. About half take positions in the public sector and half in the private sector.

PROGRAM PROJECTIONS

No changes in program structure are anticipated in the near future.

ADDITIONAL INFORMATION

The program frequently offers short courses for Professional Engineers in the field. Environmental impact assessment seminars have been presented.

COURSE DESCRIPTION (selected)

(The following is a partial listing of courses)

Chemistry: 355 Instrumental Methods of Chemical Analysis - Special analytical techniques including colorimetry, electrometric methods, electrolytic separations, polarography, spectrophotometry, X-ray spectroscopy, flame photometry and radiochemistry. (3 s.h.)

373 Atmospheric Chemistry - A chemical study of the troposhere including composition; nucleation, growth stability, distribution, diffusion, and fallout of aerosols; and meteorological aspect. (3 s.h.)

Civil Engineering: 309 City Planning - Consideration is given to each of the six major subdivisions of city planning, 309 (Cont'd) - comprising streets, transit, transportation, public recreation, zoning and civic art; history of city planning; laws governing various phases. Work includes a city layout on a topographic map with attention paid to probable future development of the city concerned. (2 s.h.)

327 Advanced Structural Design - The design of structural systems to formalize the student's knowledge of the behavior of individual components into a final integrated structure. Continuous span highway bridges, culverts, retaining walls, rigid frames, multi-storied buildings and similar type problems of interest to the student. (3 s.h.)

331 Hydraulics of Open Channels - The phenomena accompanying the flow of water in open channels, such as uniform and varied flow, critical conditions, shooting flow, backwater curves, hydraulic jump, drop, and applications are studied in detail. (3 s.h.)

333 Intermediate Fluid Mechanics I - Kinematics of fluid motion, conservation of mass, linear and angular momentum, and energy. Requirements for similarity of fluid flow. Introduction to dynamics of ideal fluids and viscous incompressible flows. Comparison of control volumes and system approaches. (3 s.h.)

336 Intermediate Fluid Mechanics II - Continuation of C.E.333 at an advanced level. General considerations of irrotational and axially symmetric incompressible irrotational flows. Advanced studies of viscous incompressible flows. Introduction to boundary layer theory. (3 s.h.)

338 Hydrologic Techniques - A study of current up-to-date hydrologic techniques involving design of hydrologic input for bridges, culverts, reservoirs. Techniques involve extreme value statistics, model hydrographs, routing, etc. (3 s.h.)

362 Public Health Engineering - A comprehensive course dealing with the environmental aspects of public health. (3 s.h.)

363 Solid Waste Management - A systematic study of the sources, amounts and characteristics of solid wastes and methods used for their collection, reclamation, and ultimate disposal. (3 s.h.)

364 Solid Waste Laboratory - A companion course to CE 363 for those students desiring experience in refuse characterization, analysis and quantity determinations along with disposal operational controls. (1 s.h.)

365 Sanitary Engineering Analysis - Quantitative measurement and benchscale pilot plant investigation in the fields of water, sewage, industrial waste, and stream pollution. Interpretation and application of test data. (3 s.h.)

367 Air Pollution Abatement I - Comprehensive study of air pollution abatement with emphasis on sources, causes, effects, and general control methods. (3 s.h.)

368 Air Pollution Abatement II - Comprehensive study of air pollution abatement with emphasis on sampling, measurement, and control. (3 s.h.)

369 Sanitary Engineering Design - Functional design of water and wastewater treatment facilities. (3 s.h.)

380 Water Resources and Engineering - Application of engineering principles to the planning and design of multipurpose water resources projects. Latest concepts in engineering analysis are utilized to enable the student to ultimately evaluate alternative solutions to water resources problems.

400 Special Investigations - Advanced work, individual in character but not leading to a thesis. (s.h. arranged)

401 Special Topics - Special lectures in an area of civil engineering of immediate interest to graduate students, which may develop into a continuing graduate course. (s.h. variable)

431 Advanced Hydraulics and Hydraulic Engineering - Studies in the field of hydraulic engineering to fit the needs of a particular student or class. Each student makes a complete design of a hydraulic development in one of the following fields; water power, sanitation, river and harbor projects. (s.h. variable)

438 Advanced Hydrology - A study of methods used in modern hydrologic analysis and design. Items of study include hydrograph analysis, maximum possible storm, infiltration, design flood determination and project feasibility. (3 s.h.)

439 Similitude and Model Studies - The use of models and analogies as aids to engineering design. Principles of dimensional analysis. Application to problems of fluid flow and structures is emphasized. (3 s.h.)

440 Urban Hydrology - Studies of the influence of urban areas on their hydrology. Special emphasis on the principles of spatially varied unsteady flow. Model hydrographs leading toward determination of design storm flow are utilized to obtain information necessary for design of storm sewers, channels, and hydraulic structures common to urban areas.

461 Sanitary Microbiology - A study of the principles and applications of the microbiology involved in environmental health and water resources engineering. (3 s.h.)

462 Water Treatment - A detailed study of the theory of water treatment with applications to design and operation. (3 s.h.)

INSTITUTION: UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

PROGRAM: Air and Industrial Hygiene (AIH)

DEPARTMENT: Environmental Sciences and Engineering

DEGREE: Master of Science (M.S.)
Master of Science in Public Health (M.S.P.H.)
Master of Science in Environmental Engineering (M.S.E.E.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Russell F. Christman, Professor and Chairman
Department of Environmental Sciences and Engineering
School of Public Health
The University of North Carolina
Chapel Hill, North Carolina 27514
(919) 966-1171

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Environmental Sciences and Engineering is a component of the School of Public Health of the University of North Carolina at Chapel Hill. The school is one of five professional schools in the university's Division of Health Sciences, and is one of nineteen such schools in the U.S. accredited by the Council on Education for Public Health. Graduate study and research in sanitary engineering were initiated in 1921. The program continually expanded and became Environmental Sciences and Engineering in 1962. In addition to Air and Industrial Hygiene, the department offers instruction and research in four other programmatic areas: Environmental Chemistry and Biology, Environmental Management and Protection, Radiological Hygiene, and Water Resources Engineering.

Students in Air and Industrial Hygiene study methods to predict, evaluate and control exposures to potentially toxic chemicals and gases in the air and at work sites. Incorporated into the curriculum are the basic disciplines of chemistry, physics, engineering, and biology. Master's students can earn the M.S., the M.S.P.H. or the M.S.E.E. degree. The M.S.P.H. degree has a public focus, and the M.S.E.E. and the M.S.P.H. are intended for those students who are preparing for scientific, technical and managerial responsibilities in municipal, state and federal agencies, or in industry and consulting engineering firms; common job titles of graduates include industrial hygienist and air pollution control specialist. To pursue similar objectives, M.S. candidates may place more emphasis on thesis research. The M.S.E.E. program is accredited by the Engineers' Council for Professional Development. Study for the Ph.D. is intended primarily for those preparing for careers in teaching and research, although the degree is becoming increasingly applicable for professional practice.

The department places heavy emphasis on research, and is involved with over seventy separate research and grant contracts in diverse environmental fields. Current areas of research related to air pollution control pertain to photo-chemical aerosol formation, photo-chemical control techniques, and coagulation of aerosols. Additionally, a large research project has been carried out related to potential hazards in the rubber industry; this was jointly sponsored by the rubber workers union and several large automobile tire manufacturers. Student research projects can be carried out in new topics, or in conjunction with existing faculty research projects. These projects often provide financial support for the student.

Specialized equipment for student research includes the usual array of laboratory instruments, an infrared analyzer, a gas chromatograph, aerosol detection equipment, and other specialized equipment. The program operates an Ambient Air Research Facility thirty miles from the university, which has two large outdoor smog chambers and laboratories. This is used for studying chemical transformations of pollutants in the atmosphere. The new air engineering laboratory houses both an industrial ventilation laboratory and an aerosol technical laboratory. A Human Exposure Chamber, operated by the U.S. Environmental Protection Agency (EPA) is situated on campus and may be utilized by AIH students for research projects. Equipment for the measurement and analysis of industrial noise is available for use by students, as is equipment for measurement of other physical agents such as heat and microwave radiation. Additional laboratory facilities are available through the Occupational Health Studies Group of the School of Public Health and at the EPA laboratories at the nearby Environmental Research Center. Modern analog and digital computer facilities are available, as are extensive shop facilities.

The department is the primary recipient of a long-term National Institute of Occupational Health Studies (NIOSH) grant for the purpose of training personnel needed to implement the Occupational Safety and Health Act. The grant has established the Occupational Safety and Health Resource Center, which is a focus for educational activities and a stimulant to multidisciplinary research in occupational safety and health.

Under contracts with the Agency for International Development (AID) the department has carried out programs of assistance and research for developing countries on the environmental impact of development. Past programs were carried out with universities in Peru and Guatemala, and with representatives of thirty-five other countries throughout the world. The department currently conducts short courses for AID and the U.N. Industrial Development Organization for personnel from developing countries in Central America and Africa.

PROGRAM REQUIREMENTS

For admission into the department, all candidates must submit at least two letters of academic reference, a statement of career objectives, the aptitude portion of the Graduate Record Examinations, and transcripts from all universities attended (the average grade point for new students enrolled in AIH in the fall of 1977 was 3.44, the average GRE score 1198). For doctoral applicants, a statement of research interests is also required.

For entrance into the M.S.E.E. program, a bachelor's degree in engineering from an ECPD accredited school or its foreign equivalent is required. An entrance requirement for the M.S.P.H. and M.S. programs is a bachelor's degree with a major in science (usually chemistry, biology, or physics), or engineering. Students should have completed successfully at least forty semester hours of science or engineering, including courses in classical and modern physics, inorganic and organic chemistry, biology and college calculus. Familiarity with physical chemistry is helpful. Those with only a bachelor's degree desiring the Ph.D. must pursue this degree through the master's degree. Students already holding master's degrees from other schools may be admitted directly or may be required to enroll for a second master's degree. Admission requires the sponsorship by a faculty member who agrees to serve as the student's program advisor. A master's degree in a similar or allied field is normally required for direct admission into the Ph.D. program.

M.S.P.H. candidates must take a basic biostatistics course, a basic epidemiology course, and five departmental courses, or fifteen hours, in a field consistent with the program area. There are no core requirements for the M.S. and M.S.E.E. degrees. Programs of study for M.S. candidates are individually designed by the student in consultation with his/her faculty advisor. M.S.E.E. programs are determined by the minimum requirements of the ECPD. A minimum of thirty semester hours of credit is required for all master's degrees, and all candidates for the M.S.E.E. and M.S.P.H. degrees must select a topic and develop an acceptable technical report and register for ENVR 392 for at least three hours in the completion of the report. M.S. candidates are required to complete and defend a formal thesis. The technical report or thesis is presented at the time of the required oral comprehensive examination.

There are no formal course requirements for the Ph.D.; a program of study is developed with the student's committee to provide mastery in the chosen field. In addition to the major, doctoral candidates must have a supporting program of at least fifteen hours; a formal minor may be elected. Two courses in a research skill are required, and all course work is examined at the time of the written examination. An approved dissertation must be prepared that is expected to be a significant and original contribution to knowledge. This is presented and defended at a final oral examination. Registration for ENVR 394 for at least three credit hours is required in the completion of the dissertation.

Approved courses for students in Air and Industrial Hygiene are listed below under Course Description. Descriptions are provided only for those offered by the department; approved courses in other departments are listed only.

CURRENT FACULTY, STUDENTS, GRADUATES

Six full-time faculty members and seven adjunct professors carry out teaching and research responsibilities within the AIH program. All faculty members have the doctorate degree, with backgrounds and major research/teaching interests in a variety of areas within air and industrial hygiene. During the 1977-1978 term, eighteen students are seeking master's degrees in the AIH program, as are thirteen seeking the Ph.D. The master's enrollment has shown a slight decline over the last three years, while enrollment in the doctoral program has substantially increased during this time period. Nine of these students are self-supporting, while the remainder receive support from research assistantships, loans, and training grants from such agencies as EPA (1), NIOSH (1), the National Oceanic and Atmospheric Administration (1), the U.S. Public Health Service (1), the Occupational Safety and Health Administration (1), and the Pan American Health Organization (1). Limited funds are also available from the State of North Carolina. The number of training grants available has substantially reduced in recent years.

During the 1976-1977 term there were eleven graduating with master's degrees in Air and Industrial Hygiene, and one with the Ph.D. During the previous year, thirteen completed a master's degree and two completed the doctorate. Over the long run, approximately one-half of the graduates with master's degrees become employed by various industrial organizations. The remaining become employed by state or federal agencies. Of the twenty-four receiving master's degrees in the two previously mentioned years, one went to a consulting firm, six to industry, eleven to government, and the employment status of one is unknown. Five are pursuing the Ph.D., four within this department. Of the three Ph.D. graduates during these years, two went to a research foundation (Research Triangle Institute) and one became the director of the Occupational Health Division in the South Carolina Department of Health and Environmental Control. It has also been common for doctoral graduates to become members of university faculties.

PROGRAM PROJECTIONS

The student enrollment in the department and within the specific programs is not expected to increase, as the department is currently authorized to admit only as many students as it graduates. A major departmental programmatic change, however, may take place within the year. Under discussion is the development of research and course offerings on the effects of contaminants on human health. As envisioned, such a development would embrace such diverse disciplines as toxicology, medicine, pharmacology, and oncology, and would tackle subjects such as the relationship of water quality to cancer incidence and the effects of air discharges on upper respiratory ailments.

How this new emphasis will be incorporated into the current departmental structure is as yet undecided. A research committee has been formed to study the alternatives and provide recommendations; money is available for several new faculty members, and efforts are underway to secure new research grants in this area.

COURSE DESCRIPTION

Environmental Sciences and Engineering Courses:

ENVR 143 Applied Physiology and Toxicology - Physiologic response of the various organs and organ systems of the body to the physical and chemical stresses of the industrial environment. The methods of industrial toxicology and the toxicological basis for the Threshold Limit Values. Concentration-Time equivalence, routes of entry, synergism are investigated in the laboratory. (3 s.h.)

ENVR 144 Air Pollution Measuring, Monitoring and Survey - Theory and application of the analysis of samples; manual methods; sensor calibration; site selection; monitoring; gas and aerosol sampling. (3 s.h.)

ENVR 145 Instrumentation and Data Acquisition - Concepts and principles employed in electronic-aided measurements of air quality including acquisition of measurements, principles of input transduction, and on-line minicomputers. (3 s.h.)

ENVR 146 Industrial Hygiene Engineering Control Design - Design of industrial exhaust systems and control of heat exposures in occupied spaces. (3 s.h.)

ENVR 146L Industrial Ventilation Laboratory - Laboratory exercises in fluid mechanics specifically related to industrial ventilation. (1 s.h.)

ENVR 147 Occupational Safety - Fundamentals of occupational safety with emphasis on legislation and organization of industrial safety programs including hazard recognition, analysis, control and motivational factors pertaining to industrial accident prevention. (2 s.h.)

ENVR 154 Management of the Institutional Environment - The study of the particular environment of hospitals, nursing homes, schools and related institutions. The application of biological and chemical methods to the identification of problems; and the epidemiology and management of environmental factors influencing health in the institutional setting. (3 s.h.)

ENVR 161 Elements of Radiological Hygiene - The physics of ionizing radiations, their interactions with matter, biological effects and principles of radiation protection. (2 s.h.)

ENVR 162 Radiation Instrumentation - A laboratory study of measurements of radioactivity with emphasis on the principles of operation of the instruments. (3 s.h.)

ENVR 211 Environmental Management - An analysis of decision-making for environmental protection programs. Case studies of environmental protection problems. (3 s.h.)

ENVR 212 Planning and Development of Environmental Hygiene Programs - Concepts and techniques in planning, organization and management. Program development, decision making, achieving administrative ends, field supervision, criteria establishment and evaluation procedures with reference to environmental hygiene programs. (3 s.h.)

ENVR 241 Introduction to Aerosol Science - Physical and chemical principles underlying behavior of particles suspended in air. Rectilinear and curvilinear motion of particles in a force field, diffusion, evaporation and condensation, electrical and optical properties and coagulation; behavior of cloud in toto. (3 s.h.)

ENVR 241L Aerosol Science Laboratory - Basic laboratory exercises in aerosol sciences. (1 s.h.)

ENVR 242 Industrial Hygiene Practice - Methodology and philosophy of evaluating the industrial environment for stresses and toxic substances which affect the health of the worker. (3 s.h.)

ENVR 243 Air and Its Contaminants -Behavior of atmospheric contaminants and the principles of making measurements in the air environment. Fundamental concepts of meteorology. (3 s.h.)

ENVR 244 Industrial Hygiene Laboratory - Principles of applying physical and chemical techniques to measure environmental exposures. Practical experiments and field studies. (3 s.h.)

ENVR 245 Air Pollution Control - Sources of air pollution and their control. Regulatory aspects and air pollution standards. (3 s.h.)

ENVR 246 Biological Effects of Air Pollution - Effects of community air pollutants on man, animals, plants and microorganisms. The "whole organism" response, data relating to biochemical response and physiological mechanisms of responses. (3 s.h.)

ENVR 247 Chemistry of the Troposphere - Sources, variability, transformation and sinks of atmospheric trace constituents in the troposphere. Photochemical and other chemical aspects of the atmosphere. Photochemical modeling, plume chemistry, air pollution chemistry. (3 s.h.)

ENVR 248 Industrial Medicine - Practice and Management - The technical factors to be considered in decision making and the roles and responsibilities of the industrial physician, nurse and industrial hygienist in the management of the work force. The etiology, diagnosis, treatment and prevention of diseases and

ENVR 248 (Cont'd) - stresses found in modern industry. (3 s.h.)

ENVR 249 Air Pollution Meteorology - Theory of transport and diffusion of air pollutants and application to practical problems and computations involving both single sources and multiple sources; modeling of transport and diffusion, in wind tunnels and computers; stack design from the meteorological point of view; the organization of meteorological network and field studies; the measurement, monitoring and equipment requirements of pertinent meteorological parameters; air pollution climatology; meteorological management of air pollution. (3 s.h.)

ENVR 283 Natural Resource Law and Policy - An examination of the law of resource use and development, its administration and underlying policies. Particular attention to water rights law, regulatory law, and natural resource administration. Regulatory aspects of pollution control programs.

Other Approved and/or Required Courses:

BIOS 105	Principles of Statistical Inference
BIOS 135	Probability and Statistics
COMP 216X	Introduction to Computer Use (no degree credit)
EPID 162	Epidemiology in Environmental Health

INSTITUTION: UNIVERSITY OF PITTSBURGH

PROGRAM: Environmental and Sanitary Engineering

DEPARTMENT: Civil Engineering

DEGREE: Bachelor of Science (B.S.)
Master of Science (M.S.)
Ph.D. in Civil Engineering

CONTACT: Dr. Joel I. Abrams
Chairman of Civil Engineering Department
University of Pittsburgh
Room 949 Benedum Hall of Engineering
Pittsburgh, Pennsylvania 15260
(412) 624-4141

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Department of Civil Engineering first started granting degrees in 1846 and fields of specialization are currently offered in Sanitary Engineering, Water Resource Engineering, and Mine Environmental Engineering and Reclamation. Graduates are employed in positions involving water resources, water supply, waste disposal, air pollution and environmental sanitation. Many graduates find positions with consulting engineering firms (including sales) in research, teaching, and governmental agencies.

Work for full-time students and a complete part-time program are strong points of the Master's degree program. Water resources and environmental engineering are specialty areas in the doctoral program and active research is on-going in both of these areas.

The Environmental and Sanitary Engineering program emphasizes research and courses in the following areas:
Chemistry and biology;
Water analysis for water quality control;
Pollution and control of natural waters;
Unit processes and operations applied to the design of water and wastewater treatment plants;
Solid waste disposal;
Disposal of sludges and concentrates;
Economics;
Administration of sanitary engineering facilities; and
Basin studies and regional environmental planning.

The Department's Sanitary Engineering Laboratories have the necessary equipment and instrumentation for determining all the

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standard wet chemical and microbiological analyses of water and wastewater. Two walk-in incubators and all the latest equipment for the newer sophisticated instrumental techniques are included in these facilities.

PROGRAM REQUIREMENTS

Applications to the graduate program may be considered on an individual basis, but for the applicant who is a recent graduate with a degree from a school accredited by the Engineer's Council for Professional Development (EPCD), admission is granted on the basis of the undergraduate record, and usually an applicant with a B average will be granted admission.

At the undergraduate level, electives are available during the sixth, seventh, and eighth terms to enable a student to pursue an individualized program in the environmental and sanitary engineering area. The Bachelor of Science degree requires completion of 121-123 credits and the undergraduate program is noted for its flexibility in accomodating student interests in environmental and sanitary engineering.

Graduate students prepare a plan of study during their first term and assistance is provided by a faculty advisor. The Master of Science degree is offered with a thesis and a non-thesis option. The thesis option requires completion of a minimum of 24 course credits (eight courses) plus a thesis (six credit minimum). Students electing the non-thesis option are required to complete ten courses for 30 course credits (minimum) and prepare a three credit project. Graduate Preliminary Examinations are given to determine the admission of a marginal case. A Comprehensive Examination is given to all non-thesis program students and to some thesis program students. A Final Oral Examination is given to evaluate the findings of the student's M.S. thesis or project and related course work. Graduate research assistants are required to write a thesis upon recommendation of the advisor and project supervisor.

In order to complete the requirements for the Doctor of Philosophy degree, a minimum of 30 course credits (ten courses) in a major area, a minimum of 18 course credits (6 courses) in a minor area (one or two minor areas, but one outside the Civil Engineering Department), a minimum of six course credits (two courses) in Analytical Techniques, and a minimum 18 credits of dissertation are required. A Plan of Study and Proposal Conference is administered by the faculty advisor and a member of the faculty in the student's major and minor areas of interest. All Ph.D. students take a Comprehensive Examination toward the end of their course work and the Final Oral Examination of three hours duration, is administered by the Doctoral Committee.

A wide variety of financial aid packages are available to graduate students enrolled in the School of Engineering. Fellowships are offered to exceptional students as an unrestricted grant. Traineeships are offered in selected areas and there are usually restrictions on the courses which are allowed to be taken. Tuition scholarships provide for partial or full remission of tuition. Research assistantships are awarded as research contracts and teaching assistantships and teaching fellowships are awarded from department funds for assistance in laboratories, recitation sections, and for other teaching duties.

CURRENT FACULTY, STUDENTS, GRADUATES

Eight faculty members teach the environmental and sanitary engineering courses offered by the Civil Engineering Department. Approximately one-half of their time is devoted to research activities. Funding for research comes from the National Institutes of Health, the Department of Energy (ERDA), the National Science Foundation, and the American Iron and Steel Institute. A joint U.S. Environmental Protection Agency and American Iron and Steel Institute project on industrial wastes will be forthcoming to the Department. Most research work by faculty in the areas of heavy metals (using biological treatment to remove heavy metals) and in the pollution effects resulting from energy production and conversion.

The Civil Engineering Department has 320 Bachelor of Science students (including 40 female) enrolled in the fall term, 1977 and 35 students (five female) have elected to take environmental and sanitary engineering courses as electives. About 100 students receive the B.S. degree annually.

At the graduate level, there are a total of 220 students (70% part-time) enrolled in the M.S. and Doctor of Philosophy degree programs in the Civil Engineering Department. Approximately 175 are M.S. candidates and 35 are Ph.D. candidates. Of students electing the environmental and sanitary engineering option, 60 are M.S. students (3 female) and 20 are Ph.D. students (one female). Approximately 35 M.S. degrees and three to four Ph.D.s are annually granted by the department. In the environmental and sanitary engineering area, about 15 of the 35 M.S. graduate and two Ph.D.s are students participating in the program.

About forty percent of the B.S. students and fifteen percent of the M.S. students continue on for advanced degrees. Most students choose to continue their studies at the University of Pittsburgh. There are many part-time students enrolled in the M.S. degree program mainly because of the availability of jobs in the area. Virtually all graduates find employment directly in their field and it is estimated that 80 percent find jobs in the private sector and 20 percent find positions in government. Most finding private sector jobs are employed in consulting engineering firms.

PROGRAM PROJECTIONS

It is not anticipated that the program will significantly increase in the foreseeable future as the Civil Engineering Department has completed a growth phase during the past two years. The program is at a plateau phase but greater emphasis may be given to sanitary engineering, laboratory experimental work, mathematical modelling, hydraulic systems, urban hydrology, and urban pollution in subsequent years. It is expected that only one additional faculty member with expertise in mathematical modelling of lakes will be recruited in the next few years.

COURSE DESCRIPTION (SELECTED)

217 Economics of Projects in Environmental and Civil Engineering - Economic theory applied to use and control of project management and evaluation. Case studies from water resource field. (3 s.h.)

218 Planning, Administration, Management and Legal Aspects of Projects in Environmental and Civil Engineering - Administrative concepts of water pollution control and other Civil Engineering Projects at all levels of government. Government planning and construction aid programs for environmental control. (3 s.h.)

240 Hydraulic Engineering - Review of fundamental hydraulics. Hydraulics of flows in closed and open conduits. Hydraulic structures. (3 s.h.)

242 Hydraulic Transport of Solids - Hydraulic transport of solids in pipelines and open channels. Hydraulics of multi-phase flows. Applications in design of slurry pipelines and open channels and sediment transport in natural waters. (3 s.h.)

244 Surface Water Hydrology - Hydrologic cycle as a deterministic and stochastic system; rainfall-runoff relations; hydrograph analysis, frequency analysis and extreme value theory; design applications. (3 s.h.)

245 Groundwater Hydrology - Mechanics of flow through porous media. Darcy's law, potential flow theory, steady and unsteady flow to wells, practical aspects of well design, numerical methods, leaky aquifer theory. (3 s.h.)

250 Sanitary Engineering Biology - The fundamentals of biology and biochemistry are discussed, particularly as applied to natural waters and wastewater treatment systems. (4 s.h.)

252 Water and Wastewater Analysis - Principles and applications of quantitative chemical analyses of water and wastewater. (4 s.h.)

254 Water Pollution of Natural Waters - Natural history of water bodies, characteristics of natural water, ecological principles, sources and effects of pollutants, assimilative capacity, oxygen balance, eutrophication, acid mine drainage, thermal pollution, stream standards, water quality monitoring, basin planning. (3 s.h.)

255 Water and Waste Treatment Plant Design - Step-by-step development of a complete plant design for a hypothetical city. Design will be rational and empirical, not theoretical. Process design, equipment selection, economic evaluation, and plant layout will be emphasized. (3 s.h.)

259 Current Topics in Environmental Resources - Group discussion of selected readings and investigation into events of current environmental interest. (3 s.h.)

265 Advanced Environmental Systems Laboratory - Functional design, simulation, and evaluation of elements of environmental systems. (Var. cr.)

267 Advanced Social and Environmental Systems Analysis - Time series analysis, estimation of recursive systems, the identification problem, estimation of simultaneous equation systems. Environmental application. (3 s.h.)

340 Selected Problems in Water Resources - Applications of theories and principles to various practical problems and current topics in water resources. (3 s.h.)

351 Unit Operations of Water Treatment - Theory of several unit processes and operations as applied to water treatment. (3 s.h.)

356 Solid Waste Disposal - Theory, design and operation of systems for the collection and disposal of solid wastes. Course includes study of composition of municipal garbage and refuse and available collection methods. (3 s.h.)

365 Environmental Assessment - Methodology of technology assessment; environmental impact analysis, environmental indicators and the strategic environmental analyses system; case studies; the 1972-74 SST review. (3 s.h.)

390-391 Sanitary and Environmental Engineering Seminar - Current sanitary and environmental engineering subjects. (1 s.h.)

INSTITUTION: UNIVERSITY OF TENNESSEE

PROGRAM: Environmental Engineering (Air Quality and Pollution Control)

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Environmental Engineering (M.S.E.E.)
Master of Engineering in Environmental Engineering (M.E.E.E.)

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PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering began as an option in the Department of Civil Engineering in 1966. The Master of Science in Environmental Engineering is designed for students whose undergraduate background is other than engineering. The Master of Engineering is accredited by the Engineers' Council for Professional Development and therefore, requires students enrolled in this program to have undergraduate degrees in engineering. The Ph.D. is offered through civil engineering, and doctoral students may elect a major in environmental engineering.

This program conducts a large number of research activities with outside funding amounting to $846,300. The largest single contributor has been the Department of Energy (formerly ERDA) for a study entitled Environmental Aspects of Coal Production in the Appalachian Region. The U.S. Air Force is providing support for studies regarding stormwater runoff.

A substantial amount of specialized research equipment exists for students' use. For air quality analysis, there are suspended particulate samplers, dustfall collectors, an MRI integrating nephelometer for visibility monitoring, a pulsed infrared laser light scattering single particle counter, an ambient particle counter, a gas analyzer for source monitoring of SO_2 and NO_x, specialized unit operations equipment, as well as other sensitive instrumentation. The library services on the Knoxville campuses are supplied by three major libraries, including a science and engineering library. Combined they contain in excess of one and one quarter million volumes. Graduates of the programs in environmental engineering are qualified for employment as consultants, urban planners, hydrologists, systems analysts, construction managers, county planners, researchers, environmental and civil engineers, and environmental chemists.

PROGRAM REQUIREMENTS

For admission to the M.S.E.E. program, one must have graduated from a recognized undergraduate curricula. It may be necessary for some articulation work to be done in preparation for certain of the technical courses. The graduate program leading to the M.E.E.E. degree is available to students who have undergraduate degrees from E.C.P.D. accredited Engineering programs. No admissions examinations are required.

All graduate students in environmental engineering must satisfy a primary core curriculum of fifteen quarter hours which consists of: ENVR 4030 or 4530 - Environmental Chemistry, ENVR 5230 or 5301 - Hydrology, ENVR 5561 (or 5501, 5502, or 5513) - Water Pollution Control, ENVR 5600 - Solid Wastes, ENVR 5710 - Air Pollution Control, ENVR 5590-Seminar. Students must then select a secondary core of concentration from the following five topic areas: water pollution control, water resources, air quality and/or pollution control, environmental science, or environmental management.

Air Quality and Pollution Control requires a secondary core of nine quarter hours which may be selected from: ENVR 5501 - Water and Wastewater Treatment Theory I, ENVR 5502 - Water and Wastewater Theory II, ENVR 5513 - Advanced Water and Wastewater Systems, ENVR 5720 - Air Pollution Particle Collection Theory, and Air Pollution Control Device Design. The program in Air Quality and Pollution Management requires the following: ENVR 5720 - Air Pollution Particle Collection Theory, ENVR 5730 - Air Pollution Control Device Design, and ENVR 5700 - Planning and Air Pollution Control.

Students have the option of writing a thesis or not. Should one prefer to write a thesis, the student must present forty-five quarter hours of approved graduate courses. The major shall include a minimum of nine credits of thesis and eighteen of environmental engineering coursework. Those individuals who prefer to pursue the non-thesis option must present a minimum of forty-eight quarter hours of graduate courses. The major must include a minimum of twenty-seven quarter credits in the environmental engineering coursework and a three hour special project.

The graduate program leading to the degree of Doctor of Philosophy is offered through the Department of Civil Engineering. Major fields of study include structural engineering, transportation engineering, and environmental engineering. For the Ph.D. degree one must complete a minimum of one hundred and eight credits beyond the baccalaureate degree, inclusive of credit earned toward a mster's thesis. Of this, a minimum of thirty-six credits are applied to doctoral research and dissertation. At least thirty-six credits must be taken in civil or environmental engineering. Approximately thirty-six credits must be in supporting, related scientific and engineering fields. These usually include such disciplines as mechanics, chemistry, mathematics, microbiology, physics, and other engineering fields. To insure scientific literacy, a student may be required to know/learn one foreign language if it is considered crucial to one's research efforts. After completion of half of the course work, each student must pass a preliminary examination. After completion of the dissertation and prior to graduation, candidates must pass a final examination administered by a faculty committee.

CURRENT FACULTY, STUDENTS, GRADUATES

Seven persons have full-time responsibility to environmental engineering. Their efforts are divided to permit approximately two-thirds of their effort to go to teaching, and the remaining one-third is devoted to research.

There are thirty-two people enrolled in both master's programs full-time and twenty-one part-time. Nearly all of these students are receiving financial assistance in the form of teaching and research assistantships. Approximately sixty percent of the students are Tennessee residents. Four of the doctoral students are pursuing environmental engineering majors.

During the academic year 1976-1977, three Ph.D. degrees and sixteen master's degrees were awarded. A follow-up study of twenty-nine recent graduates shows that twelve were employed in various government agencies, one is employed in a foreign government, three are pursuing Ph.D.'s, two are teaching, five are with consulting firms, and six with private industry.

PROGRAM PROJECTIONS

Environmental engineering is a program in the midst of tremendous growth. It is hoped that in two years a mining option with an emphasis on reclamation will be approved. This program will lead to a Bachelor of Science in Civil Engineering. In 1980-1985 it is anticipated that a Bachelor of Science in Environmental Engineering will expand the engineering offerings. In the long range plans is a B.S. in county engineering.

Two new programs have been approved at the graduate level. A Master's in Civil Engineering in Construction Management and a joint degree program in Transportation/Urban Planning are in the immediate departmental planning stage.

COURSE DESCRIPTION (SELECTED)

ENVR 5232 Sediment Transportation - Sediment properties and their measurements; bed loads and suspended load movement; erosion, scour, transportation and deposition of sediments by flowing water, silting of reservoirs and related topics. (3 q.h.)

ENVR 5234 Flood Damage Reduction - Survey of national, regional, and local flood problems; hydrologic design criteria, traditional flood control measures; and other flood damage reduction elements; interdisciplinary approach in floodplain management. (3 q.h.)

ENVR 5263 Remote Sensing Data Analysis and Interpretation - Manual and automatic methods of data analysis and interpretation; use of automatic data processing equipment. (3 q.h.)

ENVR 5310 Groundwater Transport Processes - Dynamics of flow in porous media with emphasis on physical processes important in subsurface hydrology. Hydrodynamic dispersion, anisotrophy, layered soils, and unsaturated flow phenomena. Analytical solutions of flow equations. Dupuit approximation, analog and numerical methods, Hele-Shaw, and geographical solutions. (3 q.h.)

ENVR 5502 Water and Wastewater Treatment Theory II - Theory of physical, chemical and biological processes employed in sanitary engineering. (3 q.h.)

ENVR 5513 Advanced Water and Waste Treatment Systems - Theory, operation, and use of advanced water and waste treatment systems. Emphasis on systems used for wastewater reclamation. (3 q.h.)

ENVR 5530 Environmental Engineering and Natural System Behavior - Relationship between environmental engineering and natural system behavior; focus on eutrophication and the limiting nutrient concept in relation to research and its translation into law and practice. (3 q.h.)

ENVR 5551 Water Quality Management - Water quality control objectives, methods, and philosophies; water quality criteria; regulatory standards; economic considerations. (3 q.h.)

ENVR 5561 Aquatic Environment Pollution - A study of effects resulting from agricultural, municipal, and industrial pollution upon physical, chemical, and biological characteristics of natural water. (3 q.h.)

ENVR 5582 Microbiology for Sanitary Engineers - A study of microorganisms and microbiological processes which are significant in sanitary engineering, including basic microbiology, detection and identification; enzymes, metabolic reactions, energy transfer, synthesis and growth; aerobic and anaerobic biological treatment processes. (3 q.h.)

ENVR 5593 Advanced Sanitary Engineering Laboratory - Advanced laboratory techniques used in analysis of water and wastewater. Application of modern instrumental procedures for physical, chemical, and biological analysis. (3 q.h.)

ENVR 5600 Solid Wastes - Magnitude and characteristics of the solid waste problem; methods of collection and disposal, including sanitary landfill, incineration, composting, proposed new technologies, and recycling. (3 q.h.)

ENVR 5620 Solid Waste Collection Systems - Analysis and design of collection systems, methods of collection, crew size, routing of vehicles, efficiency of collection systems, and management planning. (3 q.h.)

ENVR 5700 Planning and Air Pollution Control - Relationship between air pollution, area development, and urban growth. Social, economic, and political processes involved in air pollution control. (3 q.h.)

ENVR 5710 Air Pollution Control Engineering - Emission control systems for industrial and power generating processes, stack sampling methods, air monitoring, dispersion of pollutants. (3 q.h.)

ENVR 5720 Air Pollution Particle Collection Theory - The mechanics of particles suspended in a gaseous medium including particle motion, coagulation, and aerodynamic capture of particles. (3 q.h.)

ENVR 5725 Air Quality Modeling and Impact Assessment - Development of techniques to assess the air quality impact of major transportation projects and industrial air pollution sources. Application of atmospheric dispersion models and evaluation of meteorological and air quality data. (3 q.h.)

ENVR 5730 Air Pollution Control Device Design - Design and evaluation of systems used to control the emission of gaseous and particle air pollutants. Comprehensive design of specific devices and systems. (3 q.h.)

ENVR 5735 Industrial Source Sampling - Review and application of sampling methods for gaseous and particulate air pollutant emissions from industrial processes. (3 q.h.)

ENVR 5740 Dynamical and Physical Meteorology - Fundamental physical principles of the atmospheric sciences are developed. Specific topics include atmospheric energetics, general circulation, perturbation theory, vorticity theory, the equation of motion, solar and terrestrial radiation, and the thermodynamics of dry and moist air. (3 q.h.)

ENVR 5750 Turbulence in the Atmosphere - Present state of our knowledge of turbulence in the atmosphere. Theoretical boundary layer mean wind and temperature profiles are derived and related to observations. Methods of estimating surface fluxes, energy spectra, and cospectra are outlined. It is shown how the theories can be applied to describe changes in turbulence in air flow over urban areas. Mechanisms of formation of clear air turbulence in shear zones in the free atmosphere are suggested. (3 q.h.)

ENVR 5760 Diffusion in the Atmosphere - Movement and dilution of natural or man-made material released into the atmosphere. Basic theory is developed and observations reviewed. Specific topics include the rise of bouyant plumes, the relation between Eulerian and Lagrangian spectra, the differences between instantaneous and continuous sources, diffusion in a zone of wind shear and diffusion from urban area sources. (3 q.h.)

ENVR 6500 Industrial Waste Treatability and Process Control - Sources and characteristics of industrial wastes; treatment alternatives related to ultimate disposal, treatability and process control studies of physical, chemical, and biological processes using laboratory bench-scale treatment units. (6 q.h.)

INSTITUTION: UNIVERSITY OF TEXAS, AUSTIN

PROGRAM: Environmental Health Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.), Doctor of Philosophy (Ph.D.) in Environmental Health Engineering

CONTACT:
Dr. E. Gus Fruh
Director, Environmental Health
Engineering Laboratories
University of Texas, Austin
Austin, Texas 78712
(512) 471-5602

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

In 1965 the University of Texas at Austin, initiated a new program within the environmental health engineering options, which responded to the national concerns regarding air pollution control and abatement. The major emphasis of the environmental health engineering programs to 1965 had been in the fields of water, wastewater and related areas. Today, a strong program is still conducted in these areas, but is herewithin reported in the volumes pertinent to potable water and wastewater.

The graduate program which emphasizes air quality studies is a flexible curriculum. Students as well as faculty have a multitude of research opportunities available to them at the University of Texas. Extensive research and laboratory facilities are an integral part of the university structure. Located on the main campus are facilities for air pollution research and instruction. The air pollution research both on and off the campus, emphasizes engineering solutions to specific municipal and industrial problems throughout the southwestern United States. Currently, activities include the design of an isokinetic sampling probe, evaluation of a high volume sampling technique, particulate coagulation in automobile exhaust, development of methodologies to evaluate the air pollution potential of an urban area, and improving the particulate removal at coal burning power plants.

These graduate programs at the University of Texas, while strongly research oriented, also prepare students within a strong curriculum sequence which includes engineering design and natural science. These programs focuses on preparing professional, well-equipped persons to meet air quality related environmental problems, and on preparing practical engineering and alternative solutions. The programs lead to the Master of Science and the Doctor of Philosophy degrees.

PROGRAM REQUIREMENTS

Admission to the University of Texas-Austin graduate programs is dependent upon acceptance by the University and by the Committee on Graduate Studies. The Graduate Record Examination scores as well as academic background are reviewed and evaluated pursuant to the criteria of the Committee.

Normally the basic requirements for the Master of Science degree include completion of 30 semester hours of course work, 15 to 24 (including thesis must be in the major program. A minor is required and includes at least six semester hours of supporting subjects or subjects outside the major. Individual arrangements may be made so that a thesis is not required. Other activities as specified by the Dean must be completed satisfactorally in this event. All course work, however, must be logically related and the approval of the graduate advisor is necessary.

The requirements for completion of the Doctor of Philosophy degree are individually developed in accordance with the student's doctoral committee A language requirement is necessary, as well as a comprehensive examination in the major area, and a defense of the dissertation.

CURRENT FACULTY, STUDENTS, GRADUATES

At present, there are nine faculty members actively participating in these graduate programs. Seven are full-time and two are part-time.

Students enrolled in the air pollution section of the environmental health engineering programs total 15. Of the 15 total, 12 are master's students and include seven full-time and five part-time. At the doctoral level, there are three part-time students. Approximately four annually are awarded the Master of Science and the Doctor of Philosophy degrees.

Approximately 20% of those students receiving the Master of Science degree, historically continue their education in pursuit of the doctoral degree. About one-third of the continuing students choose the University of Texas for their doctoral studies.

Financial assistance is available in several forms including research and teaching assistantships and fellowships.

PROGRAM PROJECTIONS

The air component of the University of Texas environmental health engineering program is anticipated to expand over the next few years. In response to increased needs for well-trained engineering personnel in the field of air pollution control and abatement, the student population will increase. Pursuant to these expansion plans, one engineer with air quality expertise is proposed for addition to the current faculty. No new degree programs are planned for the near future.

COURSE DESCRIPTION (selected)

CE 390K Air and Water Analysis - Fundamental treatment of environmetAL Chemical, and biological principles. (3 s.h.)

CE 396L1 Air Pollution Evaluation - Classification, transport, transformation, effects, sampling and analysis of particulate and gaseous air pollutants in source gases and ambient air. (3 s.h.)

CE 396L2 Particulate Air Pollution Control - Principles, design and applications of inertial, scrubbing, filtration and electrostatic precipitation for particulate emission control. (3 s.h.)

CE 396L3 Gaseous Air Pollution Control - Principles, design and applications of absorption, adsorption, condensation and incineration systems for gaseous emission control. (3 s.h.)

CE 396L4 Air Pollution Control Unit Operations - Laboratory and field studies of the principles and operation of gaseous and particulate control equipment and associated source monitoring equipment.(3 s.h.)

CE 396L5 Air Quality Management - Integration of engineering, legal and economic aspects of air pollution control and air quality maintenance programs. (3 s.h.)

CE 384M Industrial Hygiene and Toxicology - Mechanism by which toxic gases, vapors and dusts produce diseases in experimental animals and man with toxic substance control in specific processes. (3 s.h.)

CE 388M Radiological Health Principles - Ionizing and electromagnetic radiation phenomena with shielding, identification dosimetry, detection, decontamination, radioactive waste management and atmospheric release containment technology. (3 s.h.)

CE 390L Environmental Analysis - Application of instrumental analyses to measurement of organic and inorganic gaseous and particulate materials in air, water and land environments. (3 s.h.)

CE 396M12 Air Pollution Meteorology - Meteorological factors relating to forecasting air pollution potential including atmospheric dispersion models for calculating air pollutant concentrations from point line and area sources. (3 s.h.)

CE 396M13 Turbulent Diffusion in the Environment - Turbulent diffusion processes of heat, mass and momentum transfer in the atmosphere affecting the dispersion and dilution of air pollutants. (3 s.h.)

ChE 384 Physics and Chemistry of Aerosols - Physical and chemical phenomena of aerosol, formation, transport, and reactions in the atmosphere. (3 s.h.)

INSTITUTION: UNIVERSITY OF WASHINGTON

PROGRAM: Air Resources

DEPARTMENT: Civil Engineering

DEGREE: Master of Science (M.S.), Doctor of Philosophy (Ph.D.) in Civil Engineering

CONTACT:
Dr. Robert J. Charlson
Dr. John Thielke
Department of Civil Engineering
University of Washington
Seattle, Washington 98195
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PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The University of Washington conducts a graduate program of research and study specifically oriented to the field of air pollution control and abatement. The air resources programs were instituted in 1963 through the auspices of the Water and Air Resources Division of the Department of Civil Engineering. The graduate programs consist of both course work and research activities. Students are encouraged to pursue substantial work in the sciences and at the same time develop expertise in the engineering aspects of problems related to air resources.

Extensive opportunities are available at the University of Washington for research. There are three major areas in which research activities are conducted and/or are planned for the future. In air resources management, projects relate to the conception and evaluation of strategies for achieving and maintaining ambient air of acceptable quality. These research activities involve emphasis of engineering, science, social, political, economic and legal aspects. Illustrative of the endeavors are activities which involve community air pollution surveys, emissions inventory, design of air quality monitoring networks, development of air quality management plans, air quality diffusion modeling, and environmental impact statements.

The second area of research, involves atmospheric chemistry. These studies deal with the degradation of atmospheric visibility due to air pollution and its relationship to the chemical properties of atmospheric aerosols. Future research is scheduled to include studies of background properties and concentrations of both atmospheric particles and gases.

The third research concentration is in the area of air pollution control. Currently there are projects being conducted on the control of particulate air pollutant emissions by wet scrubbers and electrostatic precipitators. Future projects are scheduled to include studies in the control of air pollutant emissions from such energy generating plants as coal-fired boilers and coal liquidation plants.

PROGRAM REQUIREMENTS

Admission to these air resources programs is accomplished through acceptance by the university and the Graduate School. Academic background preparation is stringently evaluated and ordinarily a student must have achieved at least a 3.00 or B average. Students admitted at the master's level do not have automatic entree into the doctoral level programs.

Generally these programs involve a high degree of flexibility and are tailored to the individual student. Normally, however, the student desiring to be considered for candidacy at the master's level, must complete a minimum of 36 semester hours at least 75% of which is in residence. Demonstration of one foreign language proficiency is required as well as a thesis (unless specifically exempted). There is also a comprehensive final examination.

Conferral of the doctoral degree is viewed by the university as the highest certification in the academic community. Requirements, therefore, are quite stringent and are tailored to the student pursuant to the appropriate doctoral committee. Normally, however, the successful completion of the Doctor of Philosophy degree requires a minimum of three years of academic study, at least two of which are in residence. In addition, minimum requirements include demonstration of reading knowledge of one or more foreign languages; preparation of a research dissertation; and, successful completion of a comprehensive examination.

CURRENT FACULTY, STUDENTS, GRADUATES

Currently, the total direct faculty complement for the air resources programs consists of three and one-half teaching and research personnel. Enrollment figures include 29 full-time students in the graduate programs. There are 19 master's students and 10 doctoral students.

Annually, approximately 11 to 12 students receive advanced degrees from these programs. Approximately 10 students per annum earn the Master of Science degree and approximately one to two per year are awarded the Doctor of Philosophy degree.

Historically, these graduates enter public sector employment. Approximately 40% enter the private sector and 60% find employment with the public sector, for example in government regulatory agencies.

PROGRAM PROJECTIONS

Long range plans for these programs involve growth and expansion. Also, the faculty plans to increase the depth and upgrade existing course offerings.

In response to these plans, one Ph.D. faculty member will be added to the staff within the next two years. This person is anticipated to have expertise in the area of design and development of air quality control equipment.

COURSE DESCRIPTION

Principle courses:

CEWA 458 The Chemistry of Air Pollution - The analytical and physical chemistry of trace atmospheric constituents, both natural and manmade. (3 s.h.)

CEWA 461 Air Resources Engineering I - Fundamental aspects of emission sources, meteorology and topography, and adverse effects on sensitive receptors. Review of the principles of air pollution control, with emphasis on engineering approaches. (3 s.h.)

CEWA 466 Air Pollution Control - Overall approach for controlling air pollution. (4 s.h.)

CEWA 467 Air Pollution Source Testing and Equipment Evaluation - Engineering evaluation of air pollutant sources and air pollution control equipment. Air pollutant source testing and stack sampling. Analysis of equipment performance and source emissions in the field and in the laboratory. (3 s.h.)

CEWA 525 Seminar in Atmospheric Problems Associated with Air Pollution - The atmospheric problems related to air pollution. (2 s.h.)

CEWA 562 Air Resources Engineering II - Sources of air pollution, including analysis of flow diagrams, raw materials, offstreams, pollution control facilities, and environmental impact. (3 s.h.)

CEWA 563 Air Resources Management - The atmosphere as a vital natural resource. (3 s.h.)

CEWA 564 Aerosol Science and Technology I - Topics relates to suspended particulate matter in a gaseous medium. Statistics, mechanics, and physical chemistry of aerosols. Particular reference to particulate matter in air and to experimental and engineering methods. (3 s.h.)

CEWA 565 Aerosol Science and Technology II - Light scattering, Brownian motion, diffusion and coagulation of aerosols. (3 s.h.)

CEWA 566 Control of Gaseous Air Pollutants - Principles and designs of the physical and chemical processes employed in the removal of gaseous pollutants. (3 s.h.)

CEWA 567 Control of Particulate Air Pollutants - Principles and designs of processes used to control the emissions of particulate air pollutants. (3 s.h.)

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Supporting courses:

CEWA 528 Acoustics of Environmental Noise - Introduction to the measurement and evaluation of environmental noise. (4 s.h.)

CEWA 555 Topics in Computer Simulation of Environmental Systems - Discussion of mathematical models and computer programs for simulating processes and systems of interest to engineers in the field of environmental pollution control and the related areas of air and water resources, solid wastes management and water and waste treatment. (3 s.h.)

Ch E 556 Principles and Applications of Colloidal Materials - Preparation, stabilization, properties and destruction of important colloidal materials. The theory and structure of the electrical double layer, electrokinetics. (4 s.h.)

Ch E 578 Environmental Protection in the Pulp and Paper Industry - Nature and sources of air and water pollution in the pulp and paper industry. Methods to remove pollutants from aqueous and gaseous effluents. (2 s.h.)

ATM S 535 The Physics of Clouds - Studies of the dynamics and microphysics of cloud and precipitation systems, with emphasis on numerical models and their verification. (3 s.h.)

ATM S 580 Atmospheric Photochemistry and Chemical Kinetics - Stratospheric and tropospheric chemistries. Concepts of chemical rate processes and photoexcitation. Photoactive species in the atmosphere. (3 s.h.)

PC EH 449 Health Effects of Air Pollution - Structure and function of the respiratory and cardiac systems and the changes that may be produced by specific air pollutants, such as ozone, carbon monoxide, SO_2, etc. (2 s.h.)

PC EH 450 Measurement and control of Air Pollution - Description of methods for air pollution research and control, including field-survey techniques, stack sampling, continuous monitoring, and use of control equipment. (2 s.h.)

PC EH 557 Control of the Industrial Environment - Principles of control of the industrial environment including noise and hazardous chemicals with special emphasis on design of exhaust-ventilation systems. (3 s.h.)

FOR R 208 Air Pollution and the Forest Environment - Types and sources of natural and man-made air pollutants, their dispersion in the atmosphere, and their ecological and economic impact on the forest ecosystem. (2 s.h.)

INSTITUTION: UNIVERSITY OF WISCONSIN-MILWAUKEE

PROGRAM: Atmospheric and Marine Environmental Program

DEPARTMENT: Energetics Department

DEGREE: Master of Science (M.S.)
Master of Engineering (M.E.)

CONTACT: Dr. K. C. Tsao
Energetics Department, Room 819
Engineering and Mathematical Sciences Building
University of Wisconsin-Milwaukee
Milwaukee, Wisconsin 53201
(414) 963-4756

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The training offered is for both undergraduate and graduate students in atmospheric and ocean sciences, pollution research and control, the design and the development of pollution detection and pollution reducing systems.

The three major areas of study are air pollution control engineering, atmospheric and marine phenomena and air pollution meteorology. The program began in 1973 with 90% of the courses being drawn from existing courses in the College of Engineering and Applied Science and the College of Letters and Sciences.

Air Pollution Control Engineering covers analytical and experimental study of combustion generated effluents; industrial, stationary and moving emission sources; air quality standards, measuring instruments and methods of control; plume dynamics and statistical modeling; cost assessment and design of equipment; and case studies.

Atmospheric and Marine Phenomena covers large scale atmospheric phenomena; atomospheric boundary layer and micrometeorology; synoptic and mesoscale prediction techniques; hydromechanics of oceans and lakes; hydromechanics of coastal environment; and air-water basins interactions.

Air Pollution Meteorology covers mesoscale and microscale atmospneric phenomena; impact of the Great Lakes on the air quality of urban shoreline areas; air pollution diffusion modeling; and monitoring of pollution by satellites, radars, lasers and photographic methods.

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PROGRAM REQUIREMENTS

Admission for freshmen is dependent on high school graduation or the equivalent; English (3 units), mathematics (2 units), academic electives (7 units), SAT or ACT scores, or other evidence of maturity and motivation. Pre-registration placement tests are required in mathematics, chemistry and foreign languages.

Students develop a distinctive, broad, flexible program to suit their needs under the close supervision of a faculty member. A Master of Engineering requires eight courses and a report/project with depth for a total of 30 credits. The Master of Science requires seven courses (24 credits) and a thesis.

CURRENT FACULTY, STUDENTS, GRADUATES

The various engineering option programs are accredited by the Engineer's Council for Professional Development (ECPD). Three faculty work with the program full-time.

In 1972 the Air Pollution Monitoring Network was funded by the State of Wisconsin and the Environmental Protection Agency for $35,000. There are nine permanent stations, seven in Milwaukee and two in the outlying areas. Students check the instruments daily. Funding is now $16,000 per year. Other monies came from National Science Foundation (NSF), the U.S. Army and Sea Grant. Total funding in 1972 was $347,800. A recent $40,000 award concerning particulate control was from the Department of Energy (DOE).

Financial support was available through research assistantships, teaching assistantships, graduate school fellowships, work study, and part-time assistantships. Presently there are three students with an average of two graduates yearly.

PROGRAM PROJECTIONS

Because of the decreasing interest and lack of funds for the support of graduate students, this program is being eliminated from the 1977-1979 catalog. The faculty has the interest but student support is lacking and student's interest is declining.

ADDITIONAL INFORMATION

Facilities include instrumented Cessna 336 Aircraft for air pollution research; joint operation of county-wide seven station air quality monitoring network; gas chromatography and emission measurement equipment; air pollution analysis laboratory with National Weather Service facsimile and teletype service, time-lapse pollution and cloud photography systems; field monitoring equipment including portable rawinsonde, pilot balloon and constant-level-balloon tracking facilities, nine station FM Communication network, mobile van with SO_2 and particulate monitors; and climatological laboratory.

In the past, a three-day workshop for the Department of Transportation has included a day's discussion of air pollution.

COURSE DESCRIPTION (a partial listing)

Undergraduate Courses:

Energetics: 330-305 Energy Conversion Laboratory - Experimental investigations in the fields of thermodynamics, fluid mechanics, heat transfer, and transport processes; testing of energy conversion devices. (3 s.h.)

330-310 Transport Processes - Introduction to fluid mechanics, heat transfer, and mass transfer; formulation and solution of engineering problems involving laminar and turbulent fluid flow, conductive, convective, and radiative energy transfer, and mass diffusion; associated laboratory experiments. (4 s.h.)

Geography: 416-414 Water Resources - Elements of the water budget; problems in planning, operation, and evaluation of works for the control and utilization of water in selected drainage basins and hydrologic regions of the earth. (3 s.h.)

Meteorology: 640-100 Survey of Meteorology - Introduction to the field of meteorology; atmospheric composition and structure; radiation and energy budget; water cycle and storms; global circulation and local winds; meteorological instruments and weather maps. (4 s.h.)

Undergraduate-Graduate Courses:

Energetics: 330-434 Air Conditioning Engineering - A study of heating and cooling of air; humidity; heating plants; refrigeration systems; controls; heat pumps. (3 s.h.)

330-435 Power Plant Design and Theory - Application of basic engineering and economic principles to the design and analysis of power production system and components; conventional fossil fuel, nuclear, gas turbine, diesel, and hydro power plants, environmental effects of present day systems and possible future alternatives. (3 s.h.)

330-440 Nuclear Power Engineering - A presentation of the basic disciplines practiced in nuclear engineering. Topics covered include nuclear physics applied to reactor calculations and reactor design. Included in reactor design are the rudiments of neutron diffusion theory, heat transfer, core hydraulics and shielding. (3 s.h.)

330-480 Air Pollution Instrumentation - A study of air pollution measuring instrumentation: meteorological instruments: basic principles; limitations; sampling techniques; demonstrations; specific area of applications. (3 s.h.)

330-680 Air Pollution Control Engineering - A study of formation and control of various air-borne effluents; source of emissions; air emission standard; control techniques, plume dynamics; applications to industrial, stationary and moving sources. (3 s.h.)

Geography: 416-418 Climate of Urban Environment - Human comfort and health; indoor climate; architectural design in different climates; urban climate and its modeling; optimal residential areas; climate of selected cities of the world; climatic trends of human environments. (3 s.h.)

416-455 Man and Climate - Climate influencing man's activity. How man changes the climate. Climate and agriculture, forestry, and man's health. Climatic quality of habitations. Climate and industry and communications. (3 s.h.)

Mechanics: 614-621 Engineering Ocean Dynamics - Water waves, tides analysis, harbor resonance, wind circulation, interaction of structures and waves, coastal transport processes, diffusion in stratified flow, tidal dynamics in estuary, pollution aspects in estuaries. (3 s.h.)

Meteorology: 640-460 Air Pollution Meteorology - Basic air chemistry; gaseous and particulate pollution sources. Microscale and mesoscale diffusion. Observation techniques: helicopter and aircraft, telemetry systems, laser radar. Control techniques. Health effects. (3 s.h.)

640-511 Dynamic Meteorology I: Radiation - Solar and longwave radiant energy in spectral, time, frequency, and spatial distributions. Radiation and energy budgets of water, ice, snow, ecosystems, and cities; atmospheric thermodynamics. (3 s.h.)

INSTITUTION: VANDERBILT UNIVERSITY

PROGRAM: Environmental and Water Resources Engineering/Air Resources

DEPARTMENT: Environmental Engineering and Policy Management

DEGREE: Master of Science (M.S.)
Master of Engineering (M.Eng.)
Doctor of Philosophy (Ph.D.)

CONTACT: Dr. Karl B. Schnelle, Jr., Chairman
Department of Environmental Engineering and Policy Management
Vanderbilt University
Nashville, Tennessee 37240
(615) 322-4757

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

Environmental engineering began at Vanderbilt in 1962. Five years later Sanitary and Water and Wastewater Resource Engineering became a department. After six major departmental changes, the name became Environmental Engineering and Policy Management.

The primary focus of advanced level studies in this department is on the development of modern quantitative techniques and their application to practical problems encountered in the field of environmental pollution and control. Advanced analytical, numerical, and statistical methods are combined with elements of water quality, systems analysis, hydraulics, biology and chemistry to provide the necessary background for conducting significant design, planning and research in the environmental area.

Current research projects include studies on thermal pollution, waste assimilation, stratified flow dynamics, industrial waste treatment, biological waste treatment, effects of pollutants on water quality in reservoirs, and methods of environmental education for the public. Students are all required to use computers in course work and are encouraged to use computer analyses in their research projects. Research needs of the program are served by the Joint University Libraries System which holds more than 1.25 million volumes and a catalogue of 6,373 periodicals. The air pollution laboratory houses a full range of sampling, flow measuring, and analytical equipment, including several automatic recording type instruments. In addition, a partial analytical equipment inventory includes a gas chromatograph, ultra-violet and infra-red spectrophotometers, Zeta Meter, and a recording polaragraph.

PROGRAM REQUIREMENTS

A bachelor's degree in engineering or science, completed with a 3.0 (on a 4.0 scale) grade average is required for admission to the Department of Environmental Engineering and Policy Management. Competence in given areas is a key factor, not necessarily how many courses one may have taken.

The normal requirements for an M.S. degree include the completion, with a B average, of at least twenty-four semester hours of formal course work, and the submission of a thesis. Students have the option in this program of following a non-thesis plan which requires thirty semester hours of graduate study, presentation of an oral report to a research seminar on a subject in the field of investigation, and submission of a written account of this work to the supervisory professor.

An advanced professional degree which is especially designed for engineering practitioners who prefer to continue working while engaged in graduate study is available. Students may complete one course at a time and have seven years to finish the Master of Engineering degree. Thirty semester hours, including twelve hours in the candidate's chosen program, are required. The remaining hours may be approved courses in other programs. At least twelve hours must be chosen from courses designated as Engineering Graduate Professional Courses.

Five options for specialization exist. They are: Water and Wasteater Treatment Engineering, Water Resources, Air Resources, Solid Waste, and Environmental Science. A core curriculum for each has been developed to guide the students through their respective programs. Should the curricula not be pursuant to the needs of a student, then together with his/her advisor, a request for variance may be filed with the director of the program. This request should be made early in the course of a student's study.

The Air Resources option requires the following: EWRE 279 - Economics and Law of Air and Water Resources, EWRE 280 - Atmospheric Pollution, EWRE 281 - Sampling and Analysis of Polluted Atmospheres, EWRE 318 - Systems Analysis for Environmental Engineers, EWRE 333 - Air Pollution Control, EWRE 334 - Air Pollution Meteorology, and MATH 252 - Statistical Analysis for Environmental Scientists and Engineers.

Individuals wishing to pursue the Doctor of Philosophy degree will design programs of study, in consultation with their advisors, which are specific to their educational objectives. The doctoral program normally takes two and one-half to three years of work beyond the M.S. degree level. The first two years are generally devoted to course work and to preparation for the general examination which admits one to doctoral candidacy. Most students require one year to complete the dissertation, work on which ensues after the second year. The final public oral examination is held after the dissertation is submitted, and consists of a thesis defense and an examination of the student's expertise in his/her field of study.

CURRENT FACULTY, STUDENTS, GRADUATES

Including the department chairman, there are the equivalent of nine full-time faculty whose primary focus is on teaching. During 1977, there were six persons enrolled in the Master of Engineering program, sixteen in the Master of Science program, and ten seeking the Ph.D. degree.

Approximately 50 percent of the graduate students are receiving financial assistance. Such aid is available to all M.S. and Ph.D. candidates in amounts up to $4,000 per year plus tuition. The EWRE program has a variety of fellowships and assistantships available. Students who are receiving support from fellowships or traineeships, or from research or teaching assistantships may take normal course loads.

While precise figures were not available, it is estimated that 40 percent of the graduates from the past three years have beem employed by the Environmental Protection Agency, 25 percent have been employed by state agencies, 10 percent by other federal agencies, and 25 percent by private consulting firms and industry.

PROGRAM PROJECTIONS

Since its inception, this department has undergone six major upheavals. The result of that constant flux is that now officials are striving to achieve departmental stability.

There is currently a moderate recruitment effort being made. Officials would like to see the master's enrollment level reach forty.

COURSE DESCRIPTION

Math 252 Statistical Analysis for Environmental Scientists and Engineers - Frequency distributions, central tendency, dispersion, classical distributions, comparison of means and variances, correlation, linear and nonlinear regression. Applications to environmental studies. (3 s.h.)

EWRE 222 Methods of Scientific Research - Scientific investigation as illustrated by study of case histories. Preparation for research, hypotheses in science, planning experimentation, the role of chance in scientific discovery, intuition in science, reasoning in science; difficulties in research, style and taste in research, strategy in research, scientific knowledge, and social values. (2 s.h.)

EWRE 270 Public Health Engineering - Principles of public health engineering, study of vector control, communicable disease control, milk and food sanitation, refuse disposal, and general environmental sanitation. (2 s.h.)

EWRE 271 Environmental Chemistry - Theoretical aspects of physical, organic, and inorganic chemistry as applied to environmental engineering problems. (3 s.h.)

EWRE 272 Microbiology of Water, Waste Water, and Air - Principles of biology and their application to environmental science with emphasis on microbiology of air, water, sewage, and industrial wastes. (4 s.h.)

EWRE 273 Environmental Chemistry Laboratory - Chemical analysis of water and waste water and the laboratory control of water purification and waste water treatment processes. (3 s.h.)

EWRE 277 Open Channel Hydraulics - Resistance in open channels. Hydraulic design of channels. Steady, non-uniform flow (backwater curves). Unsteady, non-uniform flows. Methods of characteristics. Numerical solutions for unsteady flows. (3 s.h.)

EWRE 278 Hydrology - Hydrologic cycle, study of precipitation, evapotranspiration, stream flow, flood flow, ground water, flood routing, snowmelt, and hydrometerology. (3 s.h.)

EWRE 279 Economics and Law of Air and Water Resources - Economics of air and water resource conservation and development, water rights, public policy and laws relating to air and water resources. (3 s.h.)

EWRE 280 Atmospheric Pollution - Fundamentals of atmospheric pollution and control. Sources and nature of gaseous and particulate air pollutants, relation of meteorological conditions to their dispersal, and their effects on health and materials are discussed along with administration, standards, and control of air pollution. (3 s.h.)

EWRE 295 Solid Waste Management - Introduction to problem of solid waste management; types and quantities of wastes, collection and transportation of wastes; composting, landfill, incineration; recycling of wastes and product recovery; resource management system. (3 s.h.)

EWRE 300 Water Quality Management - Effects of physical, chemical, biological, and physiological pollutants in streams, reservoirs, and estuaries; fate of pollutants in the environment; water quality criteria; water quality management methodology. Biological aspects of water quality control. (3 s.h.)

EWRE 318 Systems Analysis for Environmental Engineering - Differential equation models derived from basic principles of heat, mass and momentum transport, reaction kinetics, and mixing and blending. Digital and analog computers are used to obtain solutions to equations. Application of differential equations to problems such as the dispersion of pollutants in rivers. (3 s.h.)

EWRE 321 Water Treatment Theory and Practice - Drinking water standards, advanced study of theory of operation of water treatment operations and processes, relation of theory and design practice, analysis and design of water treatment units. (3 s.h.)

EWRE 322 Waste Treatment Theory and Practice - Theory and practice of biological waste treatment. Treatment of municipal and industrial wastewaters by biological processes. Design and operation of biological waste treatment facilities. Principles and practice of sludge dewatering and disposal. Advanced wastewater treatment. Analysis and design of waste water treatment systems. (3 s.h.)

EWRE 333 Air Pollution Control - Design and operation of air pollution control equipment. Methods of application of control in various industries. (3 s.h.)

EWRE 334 Air Pollution Meteorology - Basic meteorology of urban atmosphere and effects on air pollution. Structure and properties of atmospheric boundary layer; atmospheric turbulence and diffusion; isolated point, line volume, and area sources; buoyant plume rise; building effects; urban climatology and meteorology; urban air pollution models. (3 s.h.)

EWRE 345 Water Resources Engineering - Case studies of important problems in water resources engineering. Stratified flow, thermal pollution, eutrophication, tracer techniques, optimization techniques, submerged jets, hydraulic models, water power engineering, and water resources planning. (3 s.h.)

EWRE 362 Management of Solid Waste Collection Systems - Selected problems pertaining to reference materials, methods of collection, methods of storage, equipment and transportation. Comparison of municipal, contract, and private collection systems. Financing refuse collection operations, organization, personnel, equipment management, cost accounting and budgeting, and public relations. Analysis and planning of refuse collection systems. (3 s.h.)

EWRE 363 The Management of Solid Waste Disposal Systems - Quantities and composition of refuse, selecting disposal methods, sanitary landfill, analysis of central incineration, composting, salvage, reuse, reclamation, reprocessing, and recycling. Design and analysis of refuse disposal systems. (3 s.h.)

INSTITUTION: WASHINGTON STATE UNIVERSITY

PROGRAM: General Air Pollution

DEPARTMENT: Chemical Engineering

DEGREE: Master of Science (M.S.) in Engineering/Environmental Engineering

CONTACT:
Dr. Halvor Westberg
Associate Chemist
Chemical Engineering
Washington State University
Pullman, Washington 99163
(509) 335-1526

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

In 1971 in response to the demand for trained air pollution control personnel, the Washington State University instituted the Master of Science degree programs in the air pollution field. The degree options are of five specialities. The M.S. degree in Engineering may be granted in: chemical engineering; air pollution control engineering; and, air pollution science. The M.S. degree in environmental engineering is available under an air pollution option. Finally, the M.S. degree in environmental science, is also available under the air pollution program. The latter two degrees, while available under the air pollution option, are administered through departments other than chemical engineering, and are not herein described. The M.S. degree in engineering under the first three options, therefore, are academic degree options offered through the graduate Department of Chemical Engineering. The following is descriptive of these particular air pollution options.

The chemical engineering program and the air pollution control engineering program, are designed for students with strong undergraduate backgrounds in chemical and/or mechanical engineering. The air pollution science program has been developed for those students with undergraduate backgrounds in one of the fields of engineering or in the physical sciences.

Extensive research opportunities are available at Washington State University in air pollution, as well as other environmentally related areas. Illustrative of the excellent research facilities are the following: Nuclear Radiation Center; Electron Microscope Center; Agricultural Research Center; College of Engineering, Research Division; and Washington Water Research Center.

PROGRAM REQUIREMENTS

Admission to these air pollution programs at the graduate level, is accomplished by applying to the university. Acceptance by the university and by the Graduate School is prerequisite to admission to the program.

Requirements for the thesis degree program consist of not less than 30 semester hours, including thesis and not less than 21 semester hours of approved course work. The non-thesis requirements are similar, but include not less than 26 semester hours of approved course work and a minimum of two hours of master's special problems. In either option, no more than six semester hours may be at the 300-level.

The requirements for the three major areas basically involve: 16 semester hours of major required courses; eight semester hours (with thesis) or 10 semester hours (non-thesis) of supporting courses; and six to nine semester hours of thesis, or two to four semester hours of special problems.

CURRENT FACULTY, STUDENTS, GRADUATES

The current faculty with responsibilities for these program concentrations consists of 12 teaching and research personnel. Approximately four are cost-centered.

The enrollment includes eight males and one female full-time students. There are approximately three part-time students. On the average, five students are awarded the Master of Science degree annually. Approximately 5% elect to pursue advanced education at the doctoral level.

Financial assistance is available to students through various types of assistantships, fellowships and trainingships. Students in the air pollution programs may apply for a paid internship with the U.S. Environmental Protection Agency.

PROGRAM PROJECTIONS

Significant growth in faculty and in the student population is not expected to occur in the near future. Program changes will include the addition of new courses or the revision of present courses.

COURSE DESCRIPTION (selected)

ChE 409 Industrial Instruments - Measuring instruments, automatic control, process and instrument characteristics, and theory applied to industrial control problems. (3 s.h.)

ChE 418 Air Pollution Control Calculations - Engineering design calculations for air pollution control equipment, processes, sampling instruments, filters, scrubbers, electrostatic precipitators, and cyclones. (1 s.h.)

ChE 423 Process Development, Design and Evaluation - Development, design and economic evaluation of chemical and related processes as practiced in industry. (3 s.h.)

ChE 470 Fundamentals of Air Pollution - Sources, magnitude, and impact; chemistry of urban atmospheres, photochemistry of smog, and meteorological factors. (3 s.h.)

ChE 474 Meteorology - Meteorology and atmospheric science applied to problems in physical, environmental, agricultural, and engineering sciences; weather modification, climate change, energy problems. (2 s.h.)

ChE 508 Air Pollution Control Engineering - Measurement and control of air pollution; engineering equipment and processes. (2 s.h.)

ChE 518 Air Pollution Control Calculations - Engineering design calculations for air pollution control equipment, processes, sampling instruments, filters, scrubbers, electrostatic precipitators, and cyclones. (1 s.h.)

ChE 521 Special Topics in Air Pollution - Advanced topics in the area of industrial and urban air pollution problems and air pollution control engineering. (1-3 s.h.)

ChE 571 Air Pollution Meteorology - Weather and climate; atmospheric turbulence; transport and diffusion related to air pollution problems by modeling, statistical, and graphic treatment. (3 s.h.)

ChE 572 Air Pollution Measurement Techniques - Survey design and site selection; identification and determination of air pollutants by chemical and physical methodology; data reduction and presentation. (2 s.h.)

ChE 573 Air Pollution Abatement and Administration - Air quality managment, criteria, and standards; administration of air pollution control agencies; the enforcement process; inspection and surveillance; APEX simulation. (3 s.h.)

ChE 574 Air Pollution Seminar - Recent advances in air pollution research.

INSTITUTION: WASHINGTON UNIVERSITY

PROGRAM: Air (emphasis)

DEPARTMENT: Mechanical Engineering

DEGREE: Master of Science (M.Sc.)
Doctor of Science (D.Sc.)

CONTACT: Dr. Salvatore P. Sutera, Chairman
Dr. Rudolf B. Husar
Department of Mechanical Engineering
Box 1185, Lindell & Skinker Boulevards
St. Louis, Missouri 63130
(314) 889-6047

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The School of Engineering and Applied Science has a professional division - the Sever Institute of Technology which offers graduate degrees. The Department of Mechanical Engineering within the school does major air research.

St. Louis RAPS was a five-year program that did exclusive research on air pollution through a 25 station monitor network. Intensive studies were conducted also in which four to six institutions from throughout the United States brought their mobile equipment to St. Louis during late summer. Funding was by the EPA and amounted to $300,000 - 500,000/year. It ended in 1975.

A program sponsored by EPA began in 1972 for the training of local government people. The eight students involved were awarded a stipend and arrangments were made for release time from their jobs or their classes were scheduled in the late afternoon. This program is no longer being funded.

During the summer of 1977 an International Symposium on Sulfur in the Air was held for eight days in Yugoslavia. Sponsors were EPA, ERDA, Electric Power Research Institute, and Washington University. One hundred sixty-seven people from 22 countries participated.

PROGRAM REQUIREMENTS

Admission to the Sever Institute of Technology is dependent on University admission standards. An M.Sc.(thesis or non-thesis option) requires 30 semester hours; a D.Sc. requires 72 semester hours (including a minimum of 24 hours research). Programs are individually determined by the student and his/her advisor.

CURRENT FACULTY, STUDENTS, GRADUATES

The Department of Mechanical Engineering's faculty has thirteen members, two of whom are mainly concerned with air research. There are two additional faculty at Washington University who also have an interest, one in Chemical Engineering and one in the Department of Technology and Human Affairs.

Presently no students are working on their masters, but one is working on his D.Sc. Last year's graduates were four masters and two D.Sc.'s.

Eighty percent of engineering students receive support at Washington University. The support comes in the form of university fellowships, traineeships, research assistantships and loans.

PROGRAM PROJECTIONS

The faculty sees this program as a slowly expanding one, maintaining an average of four to five students.

COURSE DESCRIPTION (a partial listing)

ME 434 Environmental Control Systems - Environmental requirements: industrial, commercial, and special purpose rooms. Physiological and psychrometric principles, air-conditioning theory and methods. Air analysis. Design of commercial environment systems and special purpose rooms. Selection of equipment and controls. (3 s.h.)

ME 436 Industrial Air-Pollution Control - A comparison of current air-pollution control criteria, techniques for measuring industrial emissions and existing enforcement regulations in various geographical areas. Study of present methods and equipment for controlling emissions and application of those systems to a variety of specific industrial emission problems. (3 s.h.)

ME 490 Urban Air Pollution - Climate and air quality in urban areas. Sources of pollution. Meteorological aspects of air pollution. Diffusion from point, line, area, and elevated sources. Urban air-pollution models. The air-pollution episode: alert criteria and control strategy. Health effects, visibility. Air-pollution instruments, stations and systems. Current topics. (3 s.h.)

Graduate:

ME 565 Dynamics of Atmospheric Aerosols - Concentration distribution of urban air pollutants as a function of their composition, spatiotemporal emission rates from mobile and stationary sources, the urban micro-meteorology, and the chemical and physical rate processes that transform and remove the pollutants during their residence time in the atmosphere. The atmospheric aerosols will be analyzed in detail with special regard to their relationship to gaseous components, primary sources, transformation mechanisms, ME 565 (Cont'd) and effects on health and visibility. The lectures will be complemented by laboratory experiments. A term project in the form of a critical literature review, analysis and interpretation of existing data or an experimental contribution will be required. (3 s.h.)

ME 566 Experimental Methods in Air Pollution - Methods of sampling and measurement of particulate and gaseous pollutants. Laboratory work includes the use of on-line systems for measuring aerosol-size spectra, mass concentration, chemical composition, and concentration of gaseous pollutants. The application of data-acquisition and processing systems are treated in detail. Emphasis is placed on understanding the physical and chemical principles on which the measurements are based. (3 s.h.)

ME 580 Building Environmental Systems Parameters - Economic evaluation procedures. Energy-source evaluations. Energy conservation techniques. Legal restrictions: codes and ordinances, including water and air pollution, waste disposal. Occupancy requirements: physiological comfort, air quality and criteria for illumination, noise and vibration. Internal transportation: elevators, escalators, and conveyors. Estimation of operating and maintenance costs. (3 s.h.)

ME 581-582 Air-Conditioning Systems and Equipment - Combustion and energy-conversion systems. Refrigeration equipment. Heating and cooling load calculations. Ventilation and air filtration. Heat-transfer equipment design. Air-handling equipment. Room-air distribution. Air-conditioning systems: liquid and air, duct design and balancing; special space requirements and design of systems for unique structures. Part load system performance and economic evaluations. (3 s.h.)

INSTITUTION: WEST VIRGINIA UNIVERSITY

PROGRAM: Environmental Engineering

DEPARTMENT: Civil Engineering

DEGREE: Master of Science in Civil Engineering (M.S.C.E.)
Master of Science in Engineering (M.S.E.)

CONTACT: Dr. William J. Wilhelm, P.E.
Professor and Chairman of Civil Engineering
Civil Engineering Department
West Virginia University
Morgantown, West Virginia 26505
(304) 293-3867

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The environmental engineering program of the Civil Engineering Department at West Virginia University was long oriented toward sanitary engineering and hydraulics. The program was constructed mainly between 1962 and 1967. In 1963 air pollution courses were incorporated and in 1967 solid waste courses were added. In 1976, the program was expanded with the addition of water resources courses. Because at the graduate level no rigid curriculum is prescribed for the degrees of Master of Science in Civil Engineering and Master of Science in Engineering, students may specialize in two or more specialty areas. Specialties are offered in air pollution control, solid waste management, water and wastewater treatment and water resources.

Students choosing to specialize in air pollution control and abatement are prepared to assume positions in local, state or federal regulatory agencies. Many students specializing in the water areas have found positions with industrial firms (e.g., Union Carbide) and with consulting firms.

PROGRAM REQUIREMENTS

In order to enter Graduate School at West Virginia University, applicants with a baccalaureate degree, or its equivalent, from a department accredited by the Engineer's Council for Professional Development (ECPD) will be admitted on the same basis as engineering graduates of the University. If these requirements (ECPD) are not fulfilled, then the applicants must first fulfill the requirements of the department in which the advanced degree is sought.

For the Master of Science in Engineering degree, each candidate must fulfill a planned program conforming to one of the following (with the approval and discretion of the graduate committee):

(1) A minimum of 30 semester credit hours, not more than 6 of which are in research leading to an acceptable thesis.
(2) A minimum of 33 semester credit hours, not more than 3 of which are in research leading to an acceptable problem report.
(3) A minimum of 36 semester credit hours, with no thesis or problem report required.

A thesis or problem report is normally required of all candidates and a candidate shall be required to pass an examination which may be written, oral, or both, to be administered by the student's advisory and examining committee. Depending on the program followed, the examination covers course material and the thesis or problem report.

No rigid curriculum is required for the Master of Science in Civil Engineering and Master of Science in Engineering degrees. At least fifteen semester hours credit should normally be selected from graduate civil engineering courses. Only those holding a baccalaureate degree in civil engineering are allowed to complete the requirements for the Master of Science in Civil Engineering degree. The Master of Science in Engineering degree is available to students who enter the graduate program but do not possess a baccalaureate degree in civil engineering.

Financial assistance available to graduate students enrolled in the environmental engineering program includes: U.S. EPA air pollution training grants; contract research (research assistantships); one-half time teaching fellowships; National Science Foundation Coal-Energy Traineeships; and West Virginia University foundation fellowships.

CURRENT FACULTY, STUDENTS, GRADUATES

Five full-time faculty members teach the bulk of the environmental engineering courses. Assistance is provided by three adjunct professors funded through the National Institute for Occupational Safety and Health. Approximately one-half of their time is devoted to teaching and one-fourth time each devotes to research and professional activities. Current research projects they are involved with include two Department of Energy (ERDA) projects and one million dollars of state money for two projects concerning air pollution control and acid mine coal drainage control.

There are currently twenty graduate students enrolled full-time in the program and all except three are male students. There are no part-time graduate students enrolled in the program. Ten students have been graduating annually in recent years in the Master's programs. Enrollment has been rather stable over the past several years.

Few graduate students enrolled in this program continue on for additional degrees. About ninety percent find employment in their field and ten percent in a related field. Recent employment trends indicate that most graduates (75 percent) find government jobs and only 25 percent find jobs in the private sector.

PROGRAM PROJECTIONS

There is not expected to be any significant growth in this program in the next several years. Expansion primarily depends on what government research is needed in the next few years. No faculty changes are also anticipated. At West Virginia University there is an attempt to develop an Environmental Health Science Program on campus. Program officials continue to foresee environmental programs continuing to be strong as long as the federal government continues to put funds into programs through research.

COURSE DESCRIPTION (SELECTED)

146 Sanitary Engineering I - Hydrology as applied to water and waste systems. (3 s.h.)

147 Sanitary Engineering II - Examination of water and waste water, water treatment, waste water treatment and special problems in public health, air pollution, and radioactivity. (3 s.h.)

251 Public Health Engineering - Engineering aspects involved in control of the environment for the protection of health and promotion of comfort of man. (3 s.h.)

252 Water Resources Engineering - Design of water resources systems. (3 s.h.)

345 Properties of Air Pollutants - Physical, chemical, biological, and social behavioral properties of dusts, droplets, and gases in the atmosphere. (3 s.h.)

349 Solid Waste Disposal - Study of traditional patterns and problems of solid waste storage, transport, and disposal. Examination of various engineering alternatives with appropriate consideration for air and water pollution control and land reclamation. (3 s.h.)

350 Sanitary Chemistry and Biology - Theory and methods of chemical analysis of water, sewage, and industrial wastes. Biological aspects of stream pollution problems. (3 s.h.)

356 Principles of Biological Waste Treatment - Examination of biological systems used in waste treatment as to ecology and function. (3 s.h.)

446 Air Pollution Control Engineering - Study of engineering alternatives in achieving various degrees of air pollution control. (3 s.h.)

447 Air Pollution Control Standards - Comparative study of technical, economical, and social factors used in developing and establishing air pollution standards, criteria, and control limitations. (3 s.h.)

452 Water Treatment Theory - Theory of various procedures and techniques utilized in treatment of water for municipal and industrial use. (3 s.h.)

454 Industrial and Advanced Waste Treatment - Basic physical and chemical operations used in industrial and advanced waste treatment; applications for waste water reclamation and reuse; study of industrial wastes from standpoint of process, source, and treatment. (3 s.h.)

455 Municipal and Industrial Design of Solid Wastes Disposal Operations - Design criteria of existing methods and equipment for disposal of solid wastes generated by industry and municipalities: on-site preparation. (3 s.h.)

457 Hydraulics of Sanitary Engineering Works - Techniques of population growth estimation, rainfall and runoff analysis, flood flow, and ground water data to the design of sanitary works. (3 s.h.)

458 Design of Sanitary Works - Water supply and waste water disposal problems. (3 s.h.)

INSTITUTION: YALE UNIVERSITY

PROGRAM: Environmental Health

DEPARTMENT: Epidemiology and Public Health

DEGREE: Master of Public Health

CONTACT: Jan Adrianus Jozef Stolwijk, Ph.D.
Professor of Epidemiology (Environmental Health)
Yale University, School of Public Health
Department of Epidemiology and Public Health
60 College Street
New Haven, Connecticut 06510
(203) 562-9901

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The John B. Pierce Laboratory has been affiliated with Yale University since its founding in 1924. Many of the Laboratory's staff hold joint appointments at the University, primarily in the Department of Epidemiology and Public Health. The Pierce Laboratory now conducts a major portion of Yale's program in environmental health. The Laboratory's staff of physiologists, psychologists, and engineers are well known internationally for their studies of how humans respond to the environment, particularly the thermal environment. They also conduct research in air sanitation, thermal physiology, and the mechanisms of related adverse health effects.

Epidemiological and toxicological studies are also conducted by laboratory staff in order to describe and accurately assess the effect of air pollutants on human health, in the occupational and community environment. An ongoing air sanitation research program is concerned with the measurement of acute adverse effects of air pollutants in the New Haven area. Recent research has found that when combined with the blood's capacity to transport oxygen to the body's tissues. The air sanitation laboratory has devices and tools for studies of human responses to air pollution. Air sanitation laboratory staff study the pulmonary function and resistance changes in man and animals resulting from breathing noxious materials and gases.

Yale University's Division of Environmental Health, started in 1967, is concerned with the study and management and control of natural and human caused factors in the environment in their relationship to human health and well-being. Emphasis in the program is placed in providing the students a broad and sound understanding of the source and characteristics of environmental factors and the mechanism of their interaction with people.

Students who participate in the Division of Environmental Health's programs are prepared for employment by governmental and service agencies and by industry. Environmental health graduates are expected to be able to participate in and/or direct the environmental health activities and operations of a governmental, service, or industrial organization. Many graduates become directors of health districts, environmental coordinators of state health departments,sanitarians, and other administrative positions. Governmental administrative positions often are in environmental and occupational health capacities. Others find positions in unions, industry, consulting (research and teaching) and with organizations such as the Environmental Defense Fund and the American Lung Associates.

PROGRAM REQUIREMENTS

The Department of Epidemiology of Public Health requires candidates for the Master of Public Health to possess, in order to be admitted, either: (1) a graduate degree, from an acceptable institution, in a discipline relevent to public health, or (2) a bachelor's degree from an acceptable institution, with a substantial knowledge in a discipline relevent to public health either through study or experience or a combination of these. Candidates are expected to have attained an undergraduate average of B.

Students who have not had prior course work in human physiology will be expected to take Epidemiology and Public Health 111A, The Human Body in Health and Disease. All students are expected to attend the weekly seminar in environmental physiology. For graduation, all students are expected to earn satisfactorily a minimum of sixty credits, including four credits for supervised field training and nine credits for the essay.

The Division of Environmental Health's eleven required courses provide an understanding of the basic interactions between people and their environment as well as an introduction to the control and management techniques. Elective courses give students opportunities to specialize in a selected area of environmental health.
The Division's curriculum is sufficiently flexible to accomplish this. Some students may specialize in the application of control and management techniques, particularly those methods pertaining to the engineering and sanitation aspects of the environment. Research work performed in conjunction with Environmental Health 213 Research in Environmental Health, provides study opportunities to do an in-depth study in a selected area of environmental health. Some of the advanced or specialized courses are taught on a tutorial or semi-tutorial basis with the program of instruction being geared to meet the student's specific needs or interests. Students are also encouraged in the program to elect appropriate courses in other departments and schools of Yale University.

A three month summer practicum is available to students in the program between the first and second years. It affords students an opportunity to obtain "hands on" experience and bring the training gained back to class to share. Students have been sponsored by the EPA, state and local health departments, television and newspaper media and the State of New York. Also, during the second year students participate in a one day per week practical work experience. In this they are assigned to an employed environmental health person one day a week at local or state health departments. Then they write an essay examining an environmental health problem.

The Department of Epidemiology and Public Health is a participant in the Graduate and Professional School Financial Aid Service and loans and grants are awarded on the basis of need. Two pre-doctorates and two post-doctorates fellowships are available to students in the program and the National Institutes of Health are the funding source. A number of partial traineeship support is also available from the Federal government for Master's students.

CURRENT FACULTY, STUDENTS, GRADUATES

Ten faculty members contribute to the teaching and research conducted by the Division of Environmental Health. It is estimated that about 25% of their time is devoted to teaching and 75% to research. All ten are entirely supported by research funding from the National Institutes of Health, the National Science Foundation, the National Aeronautics and Space Administration, the Air Force, the American Society for Health and Engineering and the General Foods Corporation. The National Institute for Environmental Health Science funds a grant for the Divisions training program.

A total of twenty students (50% female) are currently enrolled full-time. There are no part-time students enrolled in the Division's program. Ten students annually receive the Master of Public Health degree, on the average. The number of graduates and enrollment has remained stable.

This program is designed to be a terminal program as only the Master's degree is offered. Some students do continue for doctorates, M.D.s and law degrees, however. Most that continue for doctorates do so at schools which have environmental physiology or environmental health programs. Virtually all graduates obtain employment in their field and it is estimated that one-half enter positions in the private sector and the other one-half find jobs in the public sector. Most obtain occupational health positions.

PROGRAM PROJECTIONS

Although this program is not expected to significantly change in faculty staff size, enrollment or emphasis,additional continuing education package programs are likely to be developed. These programs will be designed for people already working in the field.

Additional administrative occupational health personnel will probably be recruited to teach community and occupational health courses. These personnel may already have positions as a director of a medical corporation, for example. Additional degree programs will not be developed because doctorates are already offered in the fields of epidemiology, and environmental biostatistics.

Professionals in the field foresee a slow and steady growth in the environmental health field. The new Toxic Substances Control Act requires an enormous need for testing in stages. They feel that this program would work better if expanded because research results could be obtained if the program is doubled. Even if the program was doubled, Yale professionals in the program do not feel that the market would be flooded in the environmental health field.

COURSE DESCRIPTION

100b Introduction to Air Pollution - Principal sources and causes of air pollution, the nature and behavior of air pollutants, the effects of air pollution, and the organization and administration of control measures. (1 s.h. first half term)

112a Water Supply and Waste Water Treatment - A study of the design and operation of water supply systems and waste water treatment systems. (2 s.h.)

113b Solid Waste Management - Consideration of the fundamentals of solid waste collection, storage, processing, and disposal. (1 s.h.)

120a Principles of Radiological Health - Basic problems and programs of environmental and occupational control of ionizing radiation. (1 s.h.)

150b Introduction to Environmental Control - A survey course in environmental control which identifies the various environmental entitities that affect or may affect health and discusses the various methods of control. (2 s.h.)

151 Seminar in Environmental Control and Management - Students and guest lecturers discuss current problems of environmental control and management. (1 s.h. each term)

153b Environmental Control in Community Hygiene I - Subject matter includes air pollution, solid waste, housing and vector control. (4 s.h.)

154a Environmental Control in Community Hygiene II - Subject [illegible] includes water supply and waste water treatment, food and milk SANitation, ionizing radiation. (4 s.h.)

155 Readings in Environmental Health - Study and review of the literature in selected areas of environmental health with particular emphasis upon research and epidemiological studies. (2-4 s.h. eterm)

162b Chemical Factors in the Environment - The health effects of air pollutants and their mechanisms of action will be discussed. Also included will be the discussion of excretion of such factors as pesticides, rodenticides, and hepatotoxic agents. (3 s.h.)

165b Sensory Responses to Physical and Chemical Factors in the Environment - Examines some of the health effects of pertinent biological factors of importance in environmental control activities. (3 s.h.)

166b Control of Hazardous Chemicals in the Environment - Occupational and community exposure to hazardous chemicals; threshold limit values, criteria documentation; OSHA regulations and other standards. (2 s.h.)

INSTITUTION: AIR POLLUTION CONTROL ASSOCIATION (APCA)

PROGRAM: Refresher, Continuing Education Courses

DEPARTMENT:

DEGREE:

CONTACT:

Harold M. Englund, Editor
Air Pollution Control Association
14400 Fifth Avenue
Pittsburgh, Pennsylvania 15213
(412) 621-1090

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The Air Pollution Control Association sponsors both continuing education and refresher courses to professionals in the field during their annual meetings. The short courses are developed to meet the varying needs of the Association's membership. New technical personnel are constantly entering the air pollution field who need to be trained, and existing personnel frequently need to update or broaden their knowledge beyond the bounds of their immediate technical discipline.

During the Association's 70th Annual Meeting held in Toronto on June 16-19, 1977 a series of ten Refresher Courses and eight Continuing Education Courses were offered to its membership. The Association's Committee on Education and Training sponsored the Refresher Courses which were offered on Sunday, June 19, 1977. Attendance was limited to the first 35 persons registering for each course. Individuals attended two courses by selecting one each from Group 'A' and 'B' respectively, since each group consisted of five two-hour lectures.

APCA's eight Continuing Education short courses were offered on four days, June 16-19, 1977. The first four were offered on June 16-17, and the second four were offered on June 18-19. APCA mailed texts or course notes to all registrants prior to the Annual Meeting date to provide attendees with an opportunity to become familiar with the course material before arrival for the course.

COURSE DESCRIPTION

(the following is a partial listing of courses)

Refresher courses:

Group 'A'

A-1 "Technical Presentations: To Enlighten or Obscure" - Oral presentation of technical material poses a different set of problems than written publication. The purpose of this paper is to explain to technical personnel methods for improving oral presentations so they may communicate better and in a more interesting fashion with their colleagues and the general public.

A-2 "Citizen Involvement in Air Pollution Control Programs" - The objective of this course is to develop a better understanding of what concerned citizens are trying to do, their motivation, organization, and functions and how professionals in regulatory agencies and in industry can relate to citizen activity.

A-4 "Characterization of Power Plant Emissions" - The objective of this course is to provide a broad basis for the characterization of gaseous and particulate power plant emissions. The formation of the major pollutants will be discussed and related to modifications in combustion parameters.

A-5 "Atmospheric Inversion and Stack Design" - This course reviews the basic fundamentals of atmospheric dispersion and the applications of these principles to stack design.

Group 'B'

B-2 "Community Noise" - The purpose of this course is to emphasize the increasing awareness of the effects of noise and trends in noise technology, legislation, and enforcement.

B-3 "Passive Remote Sensing of Plume and Area Pollutants" - The operational characteristics of commercially-available passive remote sensors will be described. The problems of the fluctuating backgrounds and methods to minimize their effects will be addressed.

B-4 "Ambient Fine Particles" - This course will be an introduction to the characteristics, sources and effects of ambient fine particles including treatment in some detail of the various measurement techniques; will discuss primary and secondary production of fine particles and size distribution observations.

B-5 "Meteorological Programs for Siting of Power Plants and Industrial Facilities" - This course is designed to assist planners in understanding what meteorological data are required, why they are required, has to implement an on-site program, and how the data are to be used to determine the potential environmental impact of the proposed facility.

Continuing Education Courses:

77-1 Fundamentals of Particulate Collection

77-2 Stack Sampling and Monitoring

77-3 Industrial Control Equipment for Gaseous Pollutants

77-4 Environmental Impact Statements

77-5 Fine Particulate Behavior

77-6 Meteorology and Air Pollution Control

77-7 Continuous Monitoring Techniques Applied to Stationary Source Emissions

77-8 Electrostatic Precipitation

INSTITUTION: U.S. ENVIRONMENTAL PROTECTION AGENCY

PROGRAM: Air Pollution Training Institute

DEPARTMENT: Office of Air Quality Planning and Standards

DEGREE: Continuing Education Units/Course Certificates

CONTACT: Mr. Ronald Townsend
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Control Programs Development Division
Manpower and Technical Information Branch
Environmental Research Center
Research Triangle Park, North Carolina 27711

PROGRAM DESCRIPTION:

PROGRAM STRUCTURE

The U.S. Environmental Protection Agency (EPA) has had responsibility for the management of training and technical information services in air pollution control for EPA, and state and local air pollution control agencies since the formation of EPA in 1970. Air pollution training actually began before EPA's inception, i.e., around 1956, under public health. These activities are carried out within the Manpower and Technical Information Branch (MTIB) of the Control Programs Development Division, Office of Air Quality Planning and Standards at Research Triangle Park, North Carolina. The activities of the MTIB fall under three main categories: direct training, academic/university programs, and technical information.

Through its technical information activities, the MTIB ensures that EPA, state and local air pollution agencies, and the private sector are provided with adequate technical information. Under a contract with the Franklin Institute, the files of the Air Pollution Technical Information Center are publicly accessible on the computer system of the Lockheed Corporation. In addition to monitoring this contract, the MTIB carries out such activities as literature searches, public information dissemination, and the conduct of workshops for literature system users. The academic/university programs that the MTIB participates in include training grants, fellowships and specialty programs. Thirteen universities currently receive air pollution training grants for trainee support, and under the Fellowship Program, approximately thirty-three full-time and eighty-five part-time fellows (all state and local governmental employees) were supported during Fiscal Year (FY) 1977. Special projects of the MTIB include the New England Consortium on Environmental Protection, the Environmental Management Institute at the University of Southern California, and the automobile mechanics training program of Colorado State University.

This summary will chiefly focus upon the direct training of the MTIB that is carried out through its Air Pollution Training Institute (APTI). Since July 1, 1976, the management and operation of the APTI has been carried out under contract with Northrop Services, Inc., with its technical direction coming from the MTIB. Northrop Services is responsible for preparing and presenting courses and workshops; providing support services, technical assistance, and training materials to area training centers and to federal, state and local agency air pollution control training programs; and developing and revising training materials and courses.

In an effort to present a higher percentage of its courses at field locations rather than at Research Triangle Park, the MTIB has made contractual arrangements with a number of universities to provide for the presentation of short-term training courses. These universities are also involved in graduate training in air pollution control, and under these contracts will teach the same courses and use the same course materials as the APTI. The universities involved are the following:

1) New England Consortium on Environmental Protection
Weston, Massachusetts

2) University of Texas
Austin, Texas

3) University of Cincinnati
Cincinnati, Ohio

4) University of Southern California
Los Angeles, California

5) The Cooper Union
New York, New York

6) Rensselaer Polytechnic Institute
Troy, New York

7) University of Washington
Seattle, Washington

Presently, twenty different courses are offered by APTI staff and the contractors. During FY 1978 (October 1977 through September 1978) eighty-one courses are scheduled: thirty at or by area training centers, twenty-three at Research Triangle Park, by APTI staff, and twenty-eight at other locations throughout the United States, Puerto Rico and the Virgin Islands, also by APTI staff. Of these twenty-one are laboratory courses, the remainder lecture courses. Descriptions of these courses and the number of times offered during FY 1978 are provided below.

In addition to this direct training, the APTI also offers several other services, including self-instructional packaged courses (SI courses), instructional resource materials (IRMs) and workshops. Four SI courses are currently available (also described below), which are designed for individuals to use at their own convenience. These may be obtained from EPA regional offices on a loan basis, or purchased through the National Audiovisual Center in Washington, D.C. Five courses that are offered in the field are now available as IRMs (numbers 411, 413, 415, 431 and 444), which are designed to provide all the materials needed for a knowledgeable person to teach these particular courses. Included are student and instructor manuals, audiovisual materials, handouts, and other materials. Finally, workshops are held by MTIB/APTI staff throughout the federal regions, at EPA offices, to assist in information dissemination on newly emerging policies, technical information and regulations which are issued by Headquarters EPA. These are carried out on a monthly basis, and there are no user charges. These workshops are recorded on video tape, passed back to the regional air personnel, who are then expected to conduct one or more workshops for the appropriate state and local agency staff members, and other regional office staff and/or loan the cassettes to state and local agencies for viewing in their own offices. During FY 1977, the following workshops were held: Air Quality Emissions Handling Systems (3 times), Emissions Inventory/Permits and Registration Data Systems (3 times), Vegetation Damage (2 times), Emission Factors and Inventories (1 time), and Fabric Filter (3 times).

PROGRAM REQUIREMENTS

An application form must be submitted to the APTI registrar by each person who desires to attend a scheduled course. The cut-off date for registration is ten days prior to the beginning of classes. Each applicant must be approved prior to the course starting date by the course director. Approval is contingent upon the availability of space and whether applicants have met all prerequisites, which vary with the course. If prerequisites for a course are not met or denoted on the application form, the application is returned. In addition, pre-course learning materials are sometimes mailed to students in advance of a course, and a student is expected to complete these materials before attending.

Tuition for the courses is twenty-two dollars per student day for lecture courses and thirty-five dollars per student day for laboratory courses. Until 1974, tuition waivers were granted to governmental personnel. After this time, however, the MTIB/APTI was instructed to grant few waivers by the Federal Office of Management and Budget. The Clean Air Act Amendments of 1977 removed these user fees for public agencies and change EPA's responsibility for conducting training from discretionary to mandatory; since August 8, 1977, employees of regional, state, and local governments are exempt from payment of tuition charges.

Courses range from three to ten days in length. APTI awards Continuing Education Units (CEUs) for the satisfactory completion of its courses. One CEU is awarded for every ten hours of participation. To be eligible for receiving a course certificate and CEU credit, the participant must: a) attend a minimum of 95 percent of all classes and laboratory sessions; b) satisfactorily complete all course assignments; and c) receive a satisfactory score on the

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course examination. At the present time, undergraduate or graduate credit may not be earned through participation in these courses; such an arrangement may be available in the future through area training centers.

CEU units are not offered for SI courses or workshops. However, certificates are awarded to those who complete SI courses satisfactorily, as determined by examination.

CURRENT FACULTY, STUDENTS, GRADUATES

The MTIB has a current staff of eight to carry out all of its responsibilities and oversee the management of the APTI. Northrop Services has a staff of twenty-three which develops and offers courses, and keeps appropriate records. Additional instruction capabilities come from within the contracted universities.

The following chart depicts the state/local agency staffing level for air pollution control nationally, the number of state/local APTI trainees, other trainees, and total trainees from FY 1970 through FY 1978.

	FISCAL YEAR							
	'70	'71	'72	'73	'74	'75	'76	'77
State/local staff	3185	3790	4715	5640	6490	6800	7110	N/A
State/local trainees	1380	1701	1671	1852	1923	1240	713	961
Other trainees	729	1227	1545	1169	870	865	709	945
Total trainees	2109	2928	3216	3021	2973	2105	1422	1906

It is readily apparent that the number of participants has not increased proportionately with state/local agency staffing levels. The reasons include decreases in the MTIB training budget, MTIB staff decreases, and the institution of user charges coupled with state/local travel constraints. The number of participants is again on the rise, however, due to increased capabilities acquired through contracting; the increased number of courses offered throughout the country; the development of new, up-to-date courses devised to meet the expressed needs of regional, state and local agencies; and the increasing availability of SI courses and IRMs. In FY 1977, 170 certificates were issued for the successful completion of SI courses. Also during that year, 439 persons attended APTI workshops. Of these, 119 were state personnel, 106 were from local agencies; most of the remainder consisted of regional EPA employees.

PROGRAM PROJECTIONS

In addition to eliminating user charges, the Clean Air Act Amendments of 1977 authorize seven million dollars for air pollution control training. The MTIB/APTI has developed plans for program expansion as a result. Major highlights of these plans include increasing the number of area training centers; stepping up the development of SI courses; expanding video-tape presentations; expanding automotive training; increasing activities in academic training; and renewing efforts in manpower development (the MTIB manpower development staff was disbanded in 1973).

Little in-house staff expansion is envisioned; training capabilities would largely be increased through area training centers. A continued progressive increase of trainees is projected, however, for reasons previously mentioned. The MTIB/APTI staff will continue to seek the feedback of regional, state and local air pollution control personnel, which will play a major role in the nature of future developments. Based upon feedback, field courses, SI courses, IRMs, workshops and instructional techniques will continue to be developed and revised. The future number of fellows supported will depend upon the demand. Based upon the number of applications currently received, it appears that a significant increase will not be required.

COURSE DESCRIPTION

(Descriptions are abbreviated. More information may be obtained from the registrar of the APTI.)

SI:406 Effective Stack Height/Plume Rise - A self-instructional package designed to assist air pollution control agency personnel who are responsible for making or receiving plume rise estimates for elevated air pollution sources. Three exercises with problem sets. Suggested involvement time: 10 hours. Cost: $30.

411 Air Pollution Meteorology - Meteorological parameters and the role they play in the transport dispersion of air pollution. Designed for meteorologists, engineers and physical scientists responsible for measuring and evaluating meteorological parameters which affect the dispersion and concentration of pollutants in the atmosphere. Participants calculate estimates of continuous release pollutant concentrations and become familiar with meteorological instrumentation and correct instrument exposure. Discussions are held. 4½ day lecture course. FY 78 - 4 times.

413 Control of Particulate Emissions - The mechanisms and design parameters of particulate collection devices. Emphasis on basic theory. Problem sessions are held in which students calculate the effects of particle size distribution on efficiency and determine the efficiency of such devices as wet collectors, cyclones, fabric filtration systems, and electrostatic precipitators. 4 day lecture course. FY 78 - 6 times.

415 Control of Gaseous Emissions - Presents the basic techniques utilized for control of gaseous emissions from industrial sources. Designed to give students a knowledge and understanding of gaseous emission control equipment operation. Lectures include absorption, adsorption, and combustion theories. Students calculate the design requirements of control equipment. 4 day lecture course. FY 78 - 6 times.

420 Air Pollution Microscopy - Designed for chemists, engineers, technicians and others responsible for the collection and identification of airborne particulate matter and identification, through optical microscopic techniques, of particles in the 0.5 to 10 micrometer size range. Material is designed to give the student knowledge of the effective use of the polarizing microscope. Sample collection and handling, physical optics, illumination, crystal morphology, and analytical microscopy are discussed. 4½ day lecture course (an optional extra half day laboratory session is available). FY 78 - 2 times.

SI:422 Air Pollution Control Orientation Course - A self-instructional course intended primarily for new employees in governmental air pollution control agencies. Also useful to other persons who seek a general knowledge of the air pollution field and those with up to several years' specialized experience who need exposure to the overall air pollution control field. Audio cassette tapes and printed booklets. Suggested involvement time: 30 hours. Cost: approximately $50.

423 Dispersion of Air Pollution - Theory and Model Application - Designed for meteorologists, engineers and others having a scientific background working in the field of air pollution who have had limited experience in making atmospheric dispersion estimates or in applying dispersion models. Covers the development of selected theories of dispersion and the state-of-the-art in dispersion modeling. The application of dispersion and plume rise formulas to actual situations is discussed. 4½ day lecture course. FY 78 - 3 times.

425 Legal Aspects of Control Agency Regulatory Operations - Intended for persons who are currently or soon expect to be engaged in air pollution control agency regulatory and enforcement activity as supervisors or middle managers. Major emphasis on practical effects of legal factors on regulatory and enforcement decisions, rather than on technical questions of law. Open discussions, role-playing, and simulated proceedings. 3½ day lecture course. FY 78 - 6 times.

426 Statistical Evaluation Methods for Air Pollution Data - Designed for professionals responsible for the collection, analysis, and interpretation of air quality data. Provides an understanding of the statistical concepts and procedures needed for the detailed analysis of air pollution data. Topics are illustrated with examples. In-class exercises. 4½ day lecture course. FY 78 - 2 times.

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427 Combustion Evaluation - Designed for engineers and other personnel engaged in the evaluation of combustion processes, with specific emphasis on air pollution potential of various combustion processes. At completion, trainees are familiar with combustion principles and fundamental calculations, and are able to evaluate the air pollution potential of fossil-fuel energy sources and waste disposal incinerators. Students also can evaluate the operational characteristics of combustion devices designed to reduce the emission of air pollutants into the atmosphere. 5 day lecture course. FY 78 - 5 times.

431 Air Pollution Control Technology - Provides technical personnel newly entering the field of air pollution control with an introduction to the fundamental operating characteristics of particulate and gaseous pollutant emission control systems. Basic physical and chemical operating principles of control devices, and the application of control systems to several types of industrial processes are studied. 4 day lecture course. FY 78 - 6 times.

435 Atmospheric Sampling - An introduction to the measurement of gaseous flow and to general techniques employed in atmospheric sampling. Methods of calibration and use of flow rate measuring instruments are discussed and investigated. General techniques for sampling and reference methods for sampling and analysis of criteria pollutants are discussed. Specific characteristics of general sampling techniques are investigated in the laboratory. 4 day laboratory course. FY 78 - 4 times.

444 Air Pollution Field Enforcement - Designed for field inspectors and trainees responsible for the enforcement of air pollution laws and ordinances, or for field or engineering inspectors who handle citizen complaints or investigate cases of suspected air pollution law violations, or for those who make periodic inspections of potential air pollution sources. Emphasis on the proper manner of conducting an inspection and obtaining legal evidence of pollution emission violations. Case studies and guidelines for the conduct of an expert witness in court. 3 day lecture course. FY 78 - 6 times.

SI:448 Air Pollution Effects on Vegetation - A self-instructional course designed to afford a basic understanding of procedures helpful in identifying and verifying injury to plants caused by air pollutants. Knowledge gained includes types of vegetation which are known to be sensitive to certain pollutants and the means of identifying or excluding alternative pollutant systems. Slides, booklets, audio cassette tapes, and quizzes. Price not established. An optional companion handbook, Diagnosing Vegetation Injury Caused by Air Pollution, is also available.

450 Source Sampling for Particulate Pollutants - Presents the principles and techniques necessary for performing isokinetic source sampling procedures for particulate matter given in the

450 (Cont'd) - EPA Method 5 of the Federal New Source Performance Standards. Prepares engineers and technicians for performing and/or evaluating a particulate source test. Lectures, problem-solving experiences, laboratory exercises. 4½ day laboratory course. FY 78 - 8 times.

452 Principles and Practice of Air Pollution Control - A basic entry-level classroom course providing a broad introduction to the field of air pollution control. Intended primarily for control agency personnel with less than one year's experience, but may also be helpful to others. Emphasis on students using knowledge and concepts acquired as bases for continuing their professional development on their own. Computer-interactive simulation. 4½ day lecture course. FY 78 - 4 times.

463 Ambient Air Quality Monitoring Systems (Planning and Administrative Concepts) - Designed for chemists, engineers and other professionals who have responsibilities in the planning, administration, and operation of ambient air quality monitoring systems. Includes classroom presentations and demonstrations. Includes delineation of parameters, design of networks, network size, sampling site locations, instrument siting, probe exposure, frequency and duration of sampling, analytical methods and laboratory requirements, and data acquisition and retrieval systems. 5 day lecture course. FY 78 - 2 times.

464 Analytical Methods for Air Quality Standards - Designed for chemists and technicians responsible for the calibration, sampling, and analysis of ambient air quality samples. Emphasis on reference methods for air quality standards, including sulfur dioxide, nitrogen dioxide, photochemical oxidants, carbon monoxide, and total hydrocarbons minus methane. Quality assurance programs introduced. 10 day laboratory course. FY 78 - 1 time.

468 Source Sampling and Analysis of Gaseous Pollutants - Intended as an introduction to current Federal Reference Methods used in manual source sampling and analysis for gaseous pollutants. Designed for chemists, engineers, technicians, and other professionals presently engaged in or about to begin gaseous source sampling. 4 day laboratory course. FY 78 - 2 times.

470 Quality Assurance for Air Pollution Measurement Systems - Designed for quality assurance coordinators; managers and field or laboratory supervisors of monitoring networks; and laboratory technicians or field operators who are involved with quality assurance. Presents the basic quality management principles and techniques applicable to air pollution monitoring systems. 4 day lecture course. FY 78 - 5 times.

SI:473 Introduction to Environmental Statistics - A self-instructional package with seven programmed teaching modules. Slides and cassette tapes are used to introduce the basic concepts of statistical analysis. Intended for those with little or no

473 (Cont'd) - formal education in statistics, but who need to apply statistical techniques to the analysis of environmental data. Recommended study time: 40 hours. Cost: approximately $50.

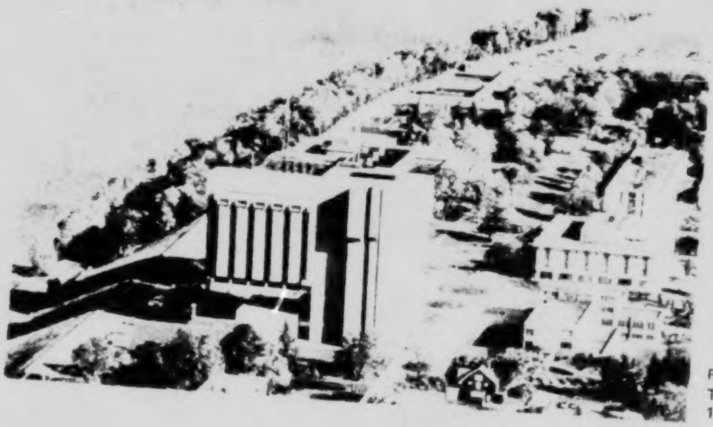
474 Continuous Emission Monitoring - Designed for engineers and other technical personnel who are responsible for the development and implementation of continuous monitoring systems for both gaseous and particulate source emissions. Federal Regulations for continuous monitoring, instrumental principles, and problems involved in developing monitoring systems are included. 5 day laboratory course. FY 78 - 4 times.

475 Comprehensive Data Handling System - Intended for persons currently using or planning to implement Air Quality Data Handling System (AQDHS-II) subsystem or the Emissions Inventory System/Permit and Registration (EIS/P&R) subsystem of the Comprehensive Data Handling System (CDHS). The purpose is to train state and local governmental air pollution control personnel in the operation and software maintenance of the subsystems. Discussion of system functions, computer runs carried out. Emphasis on retrieval capabilities and specific procedures required for meeting EPA reporting requirements. 5 day lecture course. FY 78 - 3 times.

477 Strategies and Tactics for Control Agency Administrators - A problem-oriented seminar with emphasis on the various topics in the areas of personnel management, human resources development, public and media relations, intergovernmental and interprogram relations, etc. As far as possible, the agenda is adjusted to the needs expressed in the course application. 4½ day lecture course. FY 78 - 2 times.

Other Courses Under Preparation:

- Air Quality and Emissions Data Handling Systems (SI)
- Air Quality Impact of Proposed New Sources
- Advanced Emission Control Technology
- Motor Vehicle Pollution Control
- Sources and Control of Organic Air Pollutants



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APPENDICES

Photo reprinted from the University of Illinois Institute of Technology Booklet

Photo reprinted from the Indiana University of Public and Environmental Affairs Catalog 1977-78

APPENDIX I

DEGREE ABBREVIATIONS

APPENDIX I

Degree Abbreviations

A.A.	Associate of Arts
A.A.Ag.	Associate of (in) Applied Agriculture
A.Ag.	Associate of (in) Agriculture
A.A.P.C.T.	Associate Degree in Air Pollution Control Technology
A.A.S.	Associate of Applied Science
A.B.	Bachelor of Arts
A.D.	Associate Degree
A.E.T.	Associate in Engineering Technology
A.M.T.	Associate of Mining Technology
A.N.E.T.	Associate of Nuclear Engineering Technology
A.S.	Associate in Science
A.S.E.M.T.	Associate of Science in Engineering Mining Technology
A.T.	Associate of Technology
B.A.	Bachelor of Arts
B.E.M.T.	Bachelor of Engineering in Mining Technology
B.S.	Bachelor of Science
B.S. (N.E.)	Bachelor of Science in Nuclear Engineering
B.S. (N.E.S.)	Bachelor of Science (Nuclear Engineering Sciences)
B.S. (N.R.)	Bachelor of Science in Natural Resources
B.S.A.	Bachelor of Science in Agriculture
B.S.C.E.	Bachelor of Science in Civil Engineering
B.S.Ch.E.	Bachelor of Science in Chemical Engineering
B.S.E.	Bachelor of Science in Engineering
B.S.E.H.	Bachelor of Science in Environmental Health
B.S.E. (N.E.)	Bachelor of Science (Nuclear Engineering)
B.S.E.S.	Bachelor of Science in Engineering Sciences
B.S.N.E.	Bachelor of Science in Nuclear Engineering
B.T.	Bachelor of Technology
Cert.	Certificate

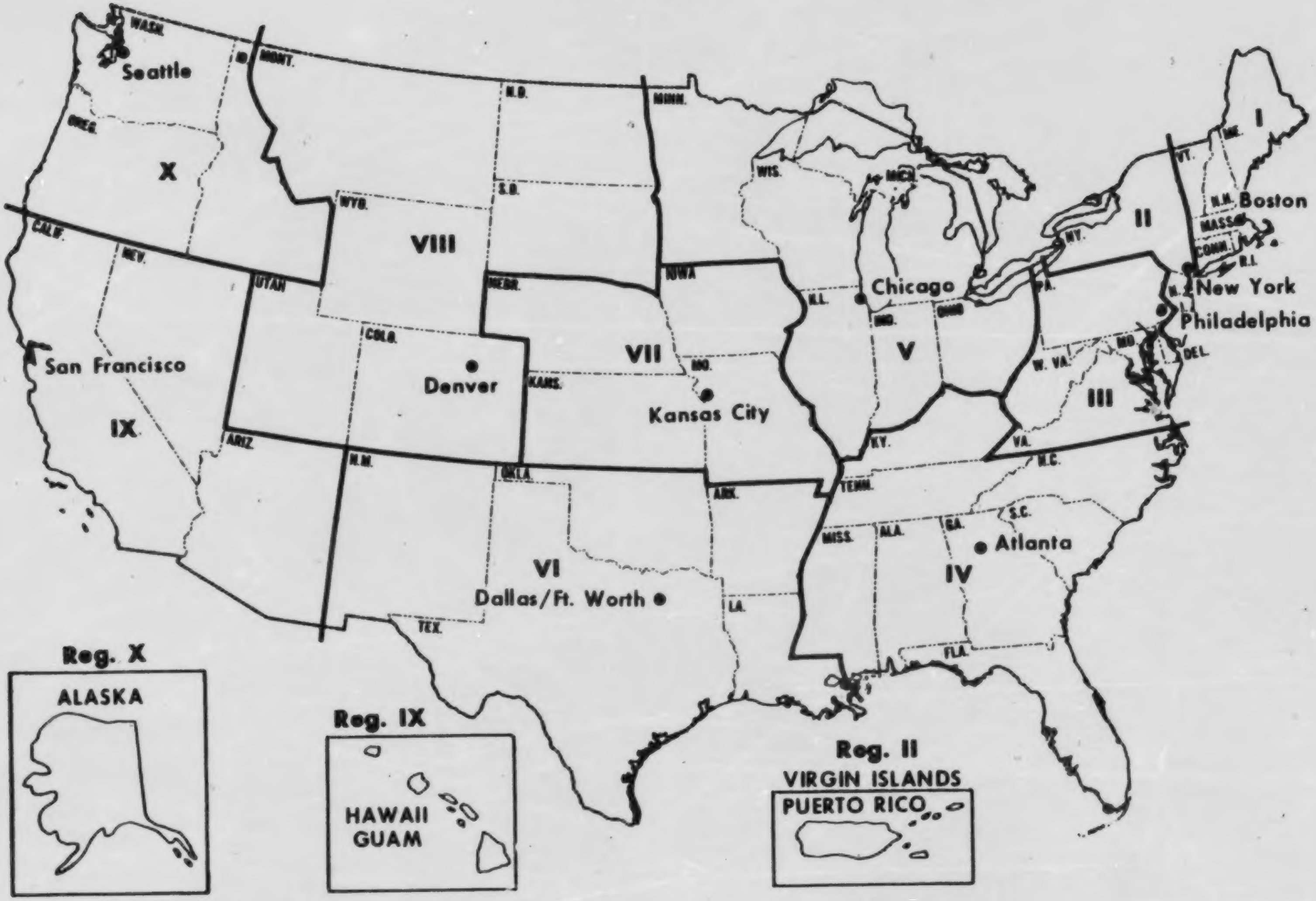
D.E.	Doctor of Engineering
D.P.H.	Doctor of Public Health
D.S.	Doctor of Science
D.S. (Hyg.)	Doctor of Science Hygiene
D.Sc.	Doctor of Science
Dr.P.H.	Doctor of Public Health
E.E.	Environmental Engineer
Eng.	Engineer
Engr.	Engineer
Engr.Sc.D.	Doctor of Engineering Science
Env.E.	Environmental Engineer
Envir.Eng.	Environmental Engineer
M.A.	Master of Arts
M.Ag.	Master of Agriculture
M.Agr.	Master of Agriculture
M.A.S.	Master of Applied Science
M.C.E.	Master of Civil Engineering
M.E.	Master of Engineering
M.E.E.E.	Master of Engineering in Environmental Engineering
M.E.A.S.	Master of Environmental Arts and Science
M.E.H.S.	Master of Environmental Health Sciences
M.E.M.	Master of Environmental Management
M.E.P.C.	Master in Environmental Pollution Control
M.Eng.	Master of Engineering
M.Engr.	Master of Engineering
M.F.	Master of Forestry
M.M.E.	Master of Mechanical Engineering
M.P.	Master of Philosophy
M.P.A.	Master of Public Affairs
M.P.H.	Master of Public Health
M.P.P.P.M.	Master of Plant Protection and Pest Management

M.P.S.	Master of Professional Studies
M.S.	Master of Science
M.S. (Hyg.)	Master of Science Hygiene
M.S.C.E.	Master of Science in Civil Engineering
M.S.Ch.E.	Master of Science in Chemical Engineering
M.S.E.	Master of Science in Engineering
M.S.E.E.	Master of Science in Environmental Engineering
M.S.En.E.	Master of Science in Environmental Engineering
M.S.Eng. S.	Master of Science in Environmental Engineering
M.S.Eng. Sci.	Master of Science in Engineering Science
M.S.E.H.	Master of Science in Environmental Health
M.S.E.M.P.	Master of Science in Energy Management and Policy
M.S.E.S.	Master of Science in Environmental Science (Studies)
M.S.P.H.	Master of Science in Public Health
M.S.(S.E.)	Master of Science in Sanitary Engineering
M.S.(S.S.)	Master of Science in Sanitary Science
N.E.	Nuclear Engineering
Nuc. Eng.	Nuclear Engineering
Ph.D.	Doctor of Philosophy
S.B.	Bachelor of Science
Sc.D.	Doctor of Science
S.M.	Master of Science

APPENDIX II

TERMINOLOGY

STANDARD REGIONAL BOUNDARIES
TEN REGIONS


WASH.
ID.
MONT.
N.D.
MINN.
OREG.
WIS.
MICH.
ME.
VT.
N.H.
MASS.
CONN.
R.I.
N.Y.
I
II
X
S.D.
WYO.
VIII
CALIF.
NEV.
UTAH
NEBR.
IOWA
ILL.
IND.
OHIO
PA.
N.J.
DEL.
MD.
W. VA.
VA.
COLO.
KANS.
MO.
VII
V
III
IX
KY.
ARIZ.
N.M.
OKLA.
ARK.
TENN.
N.C.
S.C.
GA.
ALA.
MISS.
LA.
TEX.
FLA.
VI
IV
Seattle
San Francisco
Denver
Kansas City
Chicago
Boston
New York
Philadelphia
Atlanta
Dallas/Ft. Worth
Reg. X
ALASKA
Reg. IX
HAWAII
GUAM
Reg. II
VIRGIN ISLANDS
PUERTO RICO

TERMINOLOGY

ACT (American College Testing) and SAT (Scholastic Aptitude Test) - Standardized examinations which are intended to provide applicants and institutions with a numerical statement of an individual's ability and readiness to successfully complete college/university level work.

Co-op program - A plan whereby a student receives financial assistance and academic credit under the direction of a cooperating employment site representative and a faculty advisor in exchange for an agreed upon condition of employment. Students must complete all degree requirements as per the norm.

Course - For the purpose of this study, a course is considered a unit of a program, in which a body of knowledge is presented, the satisfactory completion of which leads to the awarding of a predetermined or individually arranged number of credits.

ECPD (Engineers' Council for Professional Development) - Accrediting body for programs in engineering technology.

ERIC (Educational Resources Information Center) - A national information system designed and developed by the U.S. Office of Education, and now supported and operated by the National Institute of Education (NIE), for providing ready access to descriptions of exemplary programs, research and development efforts, and related information that can be used in developing more effective educational programs.

GRE (Graduate Record Examination) - (General Aptitude) An examination of verbal and mathematical competency and aptitude, which is designed to provide a numerical indication of an individual's ability to successfully complete advanced level work. For the purposes of the study, the GRE will not refer to the Advanced Examinations.

Internship/Applied Study Term - An arrangement which is intended to provide a simulation of work experience under the direction of academic advisors and is designed to be an integral segment of an individual's academic program. (College credit may be given.)

IRIS (Instructional Resources Information System) - A computerized information base listing materials relating to education and training in the water quality control field, which is located in the National Training and Operational Technology Center of the U.S. Environmental Protection Agency.

MEDLINE - Computerized literature search services with application to medical information.

NTIS (National Technical Information Service) - Computerized literature search services.

Program - For the purpose of this study, a plan of study, either completely prescribed, or containing options, with an identity of its own, and standard rules and procedures, the satisfaction of which may lead to a degree, certificate, or diploma.

Quarter hours - vs. - Semester hours - One semester hour is the credit equivalent to one and a half quarter hours.

Standard Federal Boundaries - Geographic division of the United States for the purposes of decentralized administration; in this report also referred to as EPA regions (see map on preceding page).

TOXLINE - Computerized literature search services with particular application to the recall of information concerning toxic substances.

WRSIC (Water Resources Scientific Information Center) - Collects, screens, organizes and disseminates reports in water resources.

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APPENDIX III

SELECTED BIBLIOGRAPHY

SELECTED BIBLIOGRAPHY

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APPENDIX IV

PARTICIPATING INSTITUTIONS
BY
ENVIRONMENTAL CATEGORY

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
AIR	Carnegie-Mellon University	Pittsburgh, PA
	Clemson University	Clemson, SC
	Drexel University	Philadelphia, PA
	George Washington University-NASA	Hampton, VA
	Harvard University School of Public Health	Boston, MA
	Hudson Valley Community College	Troy, NY
	Massachusetts Institute of Technology	Ithaca, NY
	Michigan Technological University	Houghton, MI
	Middlesex County College	Edison, NJ
	Muskingum Area Technical College	Zanesville, OH
	New Jersey Institute of Technology	Newark, NJ
	North Carolina State University	Chapel Hill, NC
	North Dakota State School of Science	Wahpeton, ND
	Northeastern University	Boston, MA
	Ohio State University	Columbus, OH
	Portland State University	Portland, OR
	Prairie State Community College	Chicago Heights, IL
	Purdue University	West Layfayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rutgers-The State University of New Jersey	New Brunswick, NJ
	Springfield Technical Community College	Springfield, MA
	Stevens Institute of Technology	Hoboken, NJ
	Sumter University	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	The Pennsylvania State University	University Park, PA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Florida	Gainesville, FL
	University of Iowa	Iowa City, IA
	University of Kentucky	Lexington, KY
	University of Maryland	College Park, MD
	University of Michigan	Ann Arbor, MI
	University of Missouri-Rolla	Rolla, MO
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Texas-Austin	Austin, TX
	University of Washington	Seattle, WA
	University of Wisconsin-Milwaukee	Milwaukee, WI
	Vanderbilt University	Nashville, TN
	Washington State University	Pullman, WA
	Washington University	St. Louis, MO
	West Virginia University	Morgantown, WV
	Yale University	New Haven, CT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE:	Antioch College	Yellow Springs, OH
	Baylor University	Waco, TX
	Bemidji State University	Bemidji, MN
	California Institute of Technology	Pasadena, CA
	California Polytechnic State University	San Luis Obispo, CA
	Catholic University of America	Washington, DC
	Carnegie-Mellon University	Pittsburgh, PA
	Chattanooga State Technical Community College	Chattanooga, TN
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Cornell University	Ithaca, NY
	Delaware Technical and Community College	Newark, DE
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	Duke University	Durham, NC
	East Central Oklahoma State University	Ada, OK
	East Tennessee State University	Johnson City, TN
	Evergreen State College	Olympia, WA
	Ferris State College	Big Rapids, MI
	Florida International University	Miami, FL
	Georgia Institute of Technology	Atlanta, GA
	Heed University	Hollywood, FL
	Hocking Technical College	Nelsonville, OH
	Howard University	Washington, DC
	Hunter College	New York, NY
	Indiana University	Bloomington, IN
	Iowa State University	Ames, IA
	Johns Hopkins University	Baltimore, MD
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Lamar University	Beaumont, TX
	Macalester College	St. Paul, MN
	Massachusetts Institute of Technology	Cambridge, MA
	McNeese State University	Lake Charles, LA
	Miami University	Oxford, OH
	Michigan State University	East Lansing, MI
	Middle Tennessee State University	Murfreesboro, TN
	Morehead State University	Morehead, KY
	Muskingum Area Technical College	Zanesville, OH
	New Jersey Institute of Technology	Newark, NJ
	North Carolina State University	Raleigh, NC
	Northland College	Ashland, WI
	Ohio State University	Columbus, OH

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE: (Cont'd)	Ohio University	Athens, OH
	Oscar Rose Junior College	Midwest City, OK
	OSU Oklahoma City Technical Institute	Oklahoma City, OK
	Polytechnical Institute of New York	Brooklyn, NY
	Princeton University	Princeton, NJ
	Purdue University	West Lafayette, IN
	Raymond Walters General and Technical College (University of Cincinnati	Cincinnati, OH
	Rensselaer Polytechnical Institute	Troy, NY
	Rutgers University	New Brunswick, NJ
	Sam Houston State University	Huntsville, TX
	Sangamon State University	Springfield, IL
	Slippery Rock State College	Slippery Rock, PA
	Springfield Technical and Community College	Springfield, MA
	Stevens Institute of Technology	Hoboken, NJ
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas A & M University	College Station, TX
	The Cooper Union	New York, NY
	The Pennsylvania State University	University Park, PA
	University of Alabama	University, AL
	University of Alaska	Fairbanks, AK
	University of Arkansas	Fayetteville, AR
	University of California-Santa Barbara	Santa Barbara, CA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Florida	Gainesville, FL
	University of Georgia	Athens, GA
	University of Kansas	Lawrence, KS
	University of Louisville	Louisville, KY
	University of Maine-Orono	Orono, Maine
	University of Michigan	Ann Arbor, MI
	University of Minnesota	Minneapolis, MN
	University of North Carolina	Chapel Hill, NC
	University of Oklahoma	Norman, OK
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Toledo	Toledo, OH
	University of Utah	Salt Lake City, UT
	University of Washington	Seattle, WA
	University of Wisconsin-Green Bay	Green Bay, WI
	University of Wisconsin-Madison	Madison, WI
	Utah State University	Logan, UT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
COMPOSITE: (Cont'd)	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Washington State University	Pullman, WA
	Western Kentucky University	Bowling Green, KY
	Western Washington University (Huxley College of Environmental Studies)	Bellingham, WA
	West Virginia University	Morgantown, WV
	Yale University	New Haven, CT
ENERGY:	Bluefield State College	Bluefield, WV
	Brigham Young University	Provo, UT
	Carnegie-Mellon University	Pittsburgh, PA
	Columbia University	New York, NY
	Cornell University	New York, NY
	Georgia Institute of Technology	Atlanta, GA
	Hartford State Technical College	Hartford, CT
	Kansas State University	Manhattan, KS
	Lamar University	Beaumont, TX
	Massachusetts Institute of Technology	Cambridge, MA
	Morehead State University	Morehead, KY
	Muskingum Area Technical College	Zanesville, OH
	Oregon State University	Corvallis, OR
	Pikeville College	Pikeville, KY
	Polytechnic Institute of New York	Brooklyn, NY
	Princeton University	Princeton, NJ
	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Southern Technical Institute	Marietta, GA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Kentucky	Lexington, KY
	University of New Mexico	Albuquerque, NM
	University of Pennsylvania	Philadelphia, PA
	University of Tennessee	Knoxville, TN
	West Virginia Institute of Technology	Montgomery, WV
	West Virginia University	Morgantown, WV

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
NOISE:	George Washington University-NASA	Hampton, VA
	Georgia Institute of Technology	Altanta, GA
	Massachusetts Institute of Technology	Cambridge, MA
	Memphis State University	Memphis, TN
	North Carolina State University	Raleigh, NC
	The Pennsylvania State University	University Park, PA
	University of Cincinnati	Cincinnati, OH
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
	University of Tennessee Center for Health Sciences	Memphis, TN
PESTICIDES:	Abraham Baldwin Agricultural College	Tifton, GA
	Broward Community College	Ft. Lauderdale, FL
	Central Technical Community College	Hastings, NE
	Delgado Community College	New Orleans, LA
	Harvard University School of Public Health	Boston, MA
	Mississippi State University	Mississippi State, MS
	New Mexico State University	Las Cruces, NM
	North Carolina State University	Raleigh, NC
	Ohio State University	Columbus, OH
	Oregon State University	Corvallis, OR
	Rutgers State University of New Jersey	New Brunswick, NJ
	State University of New York at Farmingdale	Farmingdale, NY
	Texas A & M University	College Station, TX
	The Pennsylvania State University	University Park, PA
	University of California-Berkeley	Berkeley, CA
	University of California-Davis	Davis, CA
	University of California-Riverside	Riverside, CA
	University of Cincinnati	Cincinnati, OH
	University of Delaware	Newark, DE
	University of Georgia	Athens, GA
	University of Iowa	Iowa City, IA
	University of Maryland	College Park, MD
	University of New Hampshire	Durham, NH
	University of Pittsburgh	Pittsburgh, PA
	University of Rochester	Rochester, NY
	Utah State University	Logan, UT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
POTABLE WATER:	Atlanta University Center/Georgia Institute of Technology	Atlanta, GA
	Brigham Young University	Provo, UT
	California State University	Sacramento, CA
	Carnegie-Mellon University	Pittsburgh, PA
	Casper College	Casper, WY
	Central Technical Community College	Hastings, NE
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Colorado State University	Fort Collins, CO
	Community College of Denver-Red Rocks	Golden, CO
	Cornell University	Ithaca, NY
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	East Maine Vocational Technical Institute	Bangor, ME
	Hudson Valley Community College	Troy, NY
	Illinois Institute of Technology	Chicago, IL
	Iowa State University	Ames, IA
	J. Sargeant Reynolds Community College	Richmond, VA
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Linn-Benton Community College	Albany, OR
	Manhattan College	New York, NY
	Marquette University	Milwaukee, WI
	Massachusetts Institute of Technology	Cambridge, MA
	Miami-Dade Community College	Miami, FL
	Michigan Technological University	Houghton, MI
	Middlesex Community College	Edison, NJ
	Missouri Southern State College	Joplin, MO
	Montana State University	Bozeman, MT
	Muskingum Area Technical College	Zanesville, OH
	Northeastern University	Boston, MA
	Northern Montana College	Havre, MT
	Ohio State University	Columbus, OH
	Operator Training Center	Murfreesboro, TN
	Oregon Institute of Technology	Klamath Falls, OR
	Oscar Rose Junior College	Midwest City, OK
	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rice University	Houston, TX
	Rochester Institute of Technology	Rochester, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	Southern Illinois University	Edwardsville, IL

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
POTABLE WATER: (Cont'd)	Springfield Technical Community College	Springfield, MA
	Stanford University	Stanford, CA
	State University of New York at Buffalo	Buffalo, NY
	Stevens Institute of Technology	Hoboken, NJ
	Sumter Technical Community College	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	The Pennsylvania State University/ Capitol Campus	Middletown, PA
	Tufts University	Boston, MA
	Ulster County Community College	Stone Ridge, NY
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Hawaii	Honolulu, HI
	University of Iowa	Iowa City, IA
	University of Kansas	Lawrence, KS
	University of Kentucky	Lexington, KY
	University of Maine at Orono	Orono, ME
	University of Michigan	Ann Arbor, MI
	University of Missouri-Columbia	Columbia, MO
	University of Missouri-Rolla	Rolla, MO
	University of Nebraska	Lincoln, NE
	University of North Carolina	Chapel Hill, NC
	University of Pennsylvania	Philadelphia, PA
	University of Pittsburgh	Pittsburgh, PA
	University of Rhode Island	Kingston, RI
	University of Tennessee	Knoxville, TN
	University of Texas-Austin	Austin, TX
	University of Wisconsin-Madison	Madison, WI
	University of Wyoming	Laramie, WY
	Utah State University	Logan, UT
	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Water and Wastewater Technical School	Neosho, MO
	West Georgia College	Carrollton, GA
	West Virginia University	Morgantown, WV
	Wytheville Community College	Wytheville, VA

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
RADIATION:	Central Florida Community College	Ocala, FL
	Chattanooga State Technical Community College	Chattanooga, TN
	Columbia University	New York, NY
	Cornell University	Ithaca, NY
	Hartford State Technical College	Hartford, CT
	Harvard University School of Public Health	Boston, MA
	Kansas State University	Manhattan, KS
	Massachusetts Institute of Technology	Cambridge, MA
	Memphis State University	Memphis, TN
	Missouri Southern State College	Joplin, MO
	Oak Ridge Associated Universities	Oak Ridge, TN
	Oklahoma State University	Stillwater, OK
	Rensselaer Polytechnic Institute	Troy, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	St. Louis Community College at Forest Park	St. Louis, MO
	Southern Technical Institute	Marietta, GA
	The Pennsylvania State University	University Park, PA
	University of Florida	Gainesville, FL
	University of Kansas	Lawrence, KS
	University of Lowell	Lowell, MA
	University of Maryland	College Park, MD
	University of Michigan	Ann Arbor, MI
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Tennessee	Knoxville, TN
SOLID WASTE:	Carnegie-Mellon University	Pittsburgh, PA
	Clarkson College	Potsdam, NY
	Cornell University	New York, NY
	Drexel University	Philadelphia, PA
	Hofstra University	Hempstead, NY
	Michigan Technological University	Houghton, MI
	Rensselaer Polytechnic Institute	Troy, NY
	Temple University	Philadelphia, PA
	The Pennsylvania State University	University Park, PA
	University of Iowa	Iowa City, IA
	University of Missouri-Rolla	Rolla, MO
	University of Pittsburgh	Pittsburgh, PA
	Vanderbilt University	Nashville, TN
	West Virginia University	Morgantown, WV
	Wilson County Technical Institute	Wilson, NC
	Yale University	New Haven, CT

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PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
WASTEWATER:	Atlanta University Center/ Georgia Institute of Technology	Atlanta, GA
	Brigham Young University	Provo, UT
	California State University-Sacramento	Sacramento, CA
	Carnegie-Mellon University	Pittsburgh, PA
	Casper College	Casper, WY
	Central Technical Community College	Hastings, NE
	Charles County Community College	La Plata, MD
	Clarkson College	Potsdam, NY
	Clemson University	Clemson, SC
	Colorado State University	Fort Collins, CO
	Community College of Denver-Red Rocks	Golden, CO
	Cornell University	Ithaca, NY
	Delgado College	New Orleans, LA
	Drexel University	Philadelphia, PA
	East Maine Vocational Technical Institute	Bangor, ME
	Greenville Technical College	Greenville, SC
	Harvard University	Cambridge, MA
	Hudson Valley Community College	Troy, NY
	Illinois Institute of Technology	Chicago, IL
	Iowa State University	Ames, IA
	J. Sargeant Reynolds Community College	Richmond, VA
	Kansas State University	Manhattan, KS
	Kirkwood Community College	Cedar Rapids, IA
	Linn-Benton Community College	Albany, OR
	Manhattan College	New York, NY
	Marquette Technical University	Milwaukee, WI
	Massachusetts Institute of Technology	Cambridge, MA
	Miami-Dade Community College	Miami, FL
	Michigan Technological University	Houghton, MI
	Middlesex County College	Edison, NJ
	Missouri Southern State College	Joplin, MO
	Montana State University	Bozeman, MT
	Muskingum Area Technical College	Zanesville, OH
	New England Regional Wastewater Institute	S. Portland, ME
	New Jersey Institute of Technology	Newark, NJ
	Northeastern University	Boston, MA
	Northern Montana College	Havre, MT
	Ohio State University	Columbus, OH
	Operator Training Center	Murfreesboro, TN
	Oregon Institute of Technology	Klamath Falls, OR
	Oscar Rose Junior College	Midwest City, OK

APPENDIX IV

PARTICIPATING INSTITUTIONS BY ENVIRONMENTAL CATEGORY

CATEGORY	INSTITUTION	LOCATION
WASTEWATER: (Cont'd)	Purdue University	West Lafayette, IN
	Rensselaer Polytechnic Institute	Troy, NY
	Rice University	Houston, TX
	Rochester University	Rochester, NY
	Rutgers State University of New Jersey	New Brunswick, NJ
	Southern Illinois University	Edwardsville, IL
	Springfield Technical and Community College	Springfield, MA
	Stanford University	Stanford, CA
	State Technical Institute at Memphis	Memphis, TN
	State University of New York-Buffalo	Buffalo, NY
	Stevens Institute of Technology	Hoboken, NJ
	Sumter Technical Community College	Sumter, SC
	Syracuse University	Syracuse, NY
	Temple University	Philadelphia, PA
	Texas State Technical Institute	Waco, TX
	The Pennsylvania State University	University Park, PA
	The Pennsylvania State University/ Capitol Campus	Middletown, PA
	Tufts University	Boston, MA
	Ulster County Community College	Stone Ridge, NY
	University of California-Berkeley	Berkeley, CA
	University of Florida	Gainesville, FL
	University of Hawaii	Honolulu HI
	University of Kansas	Lawrence, KS
	University of Kentucky	Lexington, KY
	University of Lowell	Lowell, MA
	University of Maine at Orono	Orono, ME
	University of Missouri-Columbia	Columbia, MO
	University of Missouri-Rolla	Rolla, MO
	University of Nebraska	Lincoln, NE
	University of North Carolina	Chapel Hill, NC
	University of Pittsburgh	Pittsburgh, PA
	University of Rhode Island	Kingston, RI
	University of Tennessee	Knoxville, TN
	University of Texas	Austin, TX
	University of Wisconsin-Madison	Madison, WI
	University of Wyoming	Laramie, WY
	Utah State University	Logan, UT
	Vanderbilt University	Nashville, TN
	Virginia Polytechnic Institute and State University	Blacksburg, VA
	Water and Wastewater Technical School	Neosho, MO
	West Georgia College	Carrollton, GA
	West Virginia University	Morgantown, WV
	Wytheville Community College	Wytheville, VA

APPENDIX V

COLLEGE CATALOGS REVIEWED

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
AL	Alabama A & M University	Huntsville
	Alabama Christian College	Montgomery
	Alabama Lutheran Junior College	Selma
	Alexander City State Junior College	Alexander City
	Athens State College	Athens
	Auburn University	Auburn
	Auburn University at Montgomery	Montgomery
	Birmingham-Southern College	Birmingham
	Brewer State Junior College	Fayette
	Enterprise State Junior College	Enterprise
	Faulkner State Junior College	Bay Minette
	Gadsden State Junior College	Gadsden
	George C. Wallace State Community College	Dothan
	George C. Wallace State Community College	Selma
	Jacksonville State University	Jacksonville
	Jefferson Davis State Junior College	Brewton
	Jefferson State Junior College	Birmingham
	John C. Calhoun State Community College	Decatur
	Judson College	Marion
	Livingston University	Livingston
	Lawson State Community College	Birmingham
	Lurleen B. Wallace State Junior College	Andalusia
	Marion Military Institute	Marion
	Miles College	Birmingham
	Mobile College	Mobile
	Northeast Alabama State Junior College	Rainsville
	Northwest Alabama State Junior College	Phil Campbell
	Oakwood College	Huntsville
	Samford University	Birmingham
	Selma University	Selma
	Snead State Junior College	Boaz
	Southeastern Bible College	Birmingham
	Southern Benedictine College	Saint Bernard
	Southern Union State Junior College	Wadley
	Spring Hill College	Mobile
	Stillman College	Tuscaloosa
	Talladega College	Talladega
	Troy State University	Troy
	Tuskeegee Institute	Tuskeegee Institute
	University of Alabama	University
	University of Alabama in Birmingham	Birmingham
	University of Alabama in Huntsville	Huntsville
	University of Montevallo	Montevallo
	University of North Alabama	Florence
	University of South Alabama	Mobile
	Walker College	Jasper
AK	Sheldon Jackson College	Sitka
	University of Alaska-Fairbanks	Fairbanks
	University of Alaska Juneau Senior College	Juneau
AS	American Samoa Community College	Pago Pago
AZ	American Graduate School of International Management	Glendale
	Arizona State University	Tempe
	Arizona Western College	Yuma

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Central Arizona College	Coolidge
	Cochise College	Douglas
	College of Ganado	Ganado
	DeVry Institute of Technology	Phoenix
	Eastern Arizona College	Thatcher
	Grand Canyon College	Phoenix
	Maricopa County Community College System Office	Phoenix
	Glendale Community College	Glendale
	Maricopa Technical Community College	Phoenix
	Mesa Community College	Mesa
	Phoenix College	Phoenix
	Scottsdale Community College	Scottsdale
	Monave Community College	Kingman
	Navajo Community College	Tsaile
	Northern Arizona University	Flagstaff
	Northland Pioneer College	Holbrook
	Pima Community College	Tucson
	Southwestern College	Phoenix
	University of Arizona	Tucson
	Yavapai College	Prescott
AR	Arkansas College	Batesville
	Arkansas State University-Main Campus	State University
	Arkansas State University-Beebe Branch	Beebe
	Arkansas Tech University	Russellville
	Central Baptist College	Conway
	College of the Ozarks	Clarksville
	Crowley's Ridge College	Paragould
	Garland County Community College	Hot Springs
	Harding College-Main Campus	Searcy
	Henderson State University	Arkadelphia
	Hendrix College	Conway
	John Brown University	Siloam Springs
	Mississippi County Community College	Blytheville
	Quachita Baptist University	Arkadelphia
	Philander Smith College	Little Rock
	Phillips County Community College	Helena
	Southern Arkansas University	Magnolia
	Southern Arkansas University Southwest Technical Institute	East Camden
	Southern Baptist College	Walnut Ridge
	Southern State College	Magnolia
	University of Arkansas-Main Campus	Fayetteville
	University of Arkansas-Little Rock	Little Rock
	University of Arkansas Medical Sciences Campus	Little Rock
	University of Arkansas-Monticello	Monticello
	Westlark Community College	Fort Smith
CA	Allan Hancock College	Santa Maria
	Ambessador College	Pasadena
	American Baptist Seminary of the West-Central Office	Berkeley
	American Baptist Seminary of the West-Covina	Covina
	Armstrong College	Berkeley
	Azusa Pacific College	Azusa
	Bakersfield College	Bakersfield
	Barstow College	Barstow
	Bauder College	Sacramento
	Bethany Bible College	Santa Cruz
	Biola College	La Mirada
	Brooks College	Long Beach

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Brooks Institute of Santa Barbara	Santa Barbara
	Butte College	Oroville
	Cabrillo College	Aptos
	California Baptist College	Riverside
	California College of Arts and Crafts	Oakland
	California Institute of the Arts	Valencia
	California Institute of Asian Studies	San Francisco
	California Institute of Technology	Pasadena
	California Lutheran College	Thousand Oaks
	California Maritime Academy	Vallejo
	California State College-San Bernadino	San Bernardino
	California State College-Stanislaus	Turlock
	California Polytechnic State University-San Luis Obispo	San Luis Obispo
	California State University-Fresno	Fresno
	California State University-Fullerton	Fullerton
	California State University-Hayward	Hayward
	California State University-Long Beach	Long Beach
	California State University-Los Angeles	Los Angeles
	California State University-Sacramento	Sacramento
	San Diego State University	San Diego
	San Jose State University	San Jose
	Cerritos College	Norwalk
	Cerro Coso Community College	Ridgecrest
	Chapman College	Orange
	Christian Heritage College	El Cajon
	Church Divinity School of the Pacific	Berkeley
	Citrus College	Azusa
	Claremont Colleges-System Office	Claremont
	Claremont Men's College	Claremont
	Claremont University Center and Graduate School	Claremont
	Harvey Mudd College	Claremont
	Pitzer College	Claremont
	Pomona College	Claremont
	Scripps College	Claremont
	Coast Community College-System Office	Costa Mesa
	Golden West College	Huntington Beach
	Orange Coast College	Costa Mesa
	Cogswell College	San Francisco
	Colegio De La Tierra	Goshen
	College of the Canyons	Valencia
	College of the Desert	Palm Desert
	College of Marin	Kentfield
	College of Notre Dame	Belmont
	College of the Redwoods	Eureka
	College of the Siskiyous	Weed
	Columbia Junior College	Columbia
	Compton Community College	Compton
	Contra Costa Community College-System Office	
	Diablo Valley College	Pleasant Hill
	Cuesta College	San Luis Obispo
	Cypress College	Cypress
	Dominican College of San Rafael	San Rafael
	El Camino College	Torrance
	Foothill-De Anza Community College District-System Office	Los Altos Hills
	De Anza College	Cupertino
	Foothill College	Los Altos Hills
	Fuller Theological Seminary	Pasadena
	Gavilan College	Gilroy
	Glendale Community College	Glendale
	Golden Gate University	San Francisco
	Grossmont College	El Cajon
	Hartnell College	Salinas
	Holy Family College	Mission San Jose

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Holy Names College	Oakland
	Immaculate Heart College	Los Angeles
	Indian Valley Colleges	Novato
	John F. Kennedy University	Orinda
	Lake Tahoe Community College	S. Lake Tahoe
	Lassen College	Susanville
	LaVerne College	La Verne
	L.I.F.E. Bible College	Los Angeles
	Lincoln University	San Francisco
	Lone Mountain College	San Francisco
	Long Beach City College	Long Beach
	Los Angeles Baptist College	Newhall
	Los Angeles Community College-System Office	Los Angeles
	East Los Angeles College	Los Angeles
	Los Angeles City College	Los Angeles
	Los Angeles Harbor College	Wilmington
	Los Angeles Mission College	San Fernando
	Los Angeles Pierce College	Woodland Hills
	Los Angeles Southwest College	Los Angeles
	Los Angeles Valley College	Van Nuys
	West Los Angeles College	Culver City
	Los Rios Community College-System Office	Sacramento
	Cosumnes River College	Sacramento
	Sacramento City College	Sacramento
	Loyla Marymount University	Los Angeles
	Marymount Palos Verdes College	Rancho Palos Verdes
	Mendocino College	Ukiah
	Menlo College	Menlo Park
	Mennonite Brethren Biblical Seminary	Fresno
	Merced College	Merced
	Mills College	Oakland
	Monterey Institute for Foreign Studies	Monterey
	Monterey Peninsula College	Monterey
	Mount San Antonio College	Walnut
	Mount San Jacinto College	San Jacinto
	Napa College	Napa
	National University	San Diego
	New College of California	San Francisco
	Northrop University	Inglewood
	Occidental College	Los Angeles
	Ohlone College	Fremont
	Otis Art Institute of Los Angeles County	Los Angeles
	Pacific Christian College	Fullerton
	Pacific College	Fresno
	Pacific Oaks College	Pasadena
	Pacific School of Religion	Berkeley
	Pacific Union College	Angwin
	Palomar College	San Marcos
	Palo Verde College	Blythe
	Pasadena City College	Pasadena
	Patten Bible College	Oakland
	Pepperdine University	Malibu
	Peralta Community Colleges-System Office	Oakland
	College of Alameda	Alameda
	Point Loma College	San Diego
	Porterville College	Porterville
	Rand Graduate Institute of Policy Studies	Santa Monica
	Riverside City College	Riverside
	Rosemead Graduate School of Psychology	Rosemead
	Saddleback Community College	Mission Viejo
	Saint Mary's College of California	Moraga

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Saint Patrick's College	Mountain View
	San Diego Community College-Central Office	San Diego
	San Diego Community College-City College	San Diego
	San Diego Community College-Evening College	
	San Francisco Art Institute	San Francisco
	San Francisco Conservatory of Music	San Francisco
	San Francisco Theological Seminary	San Anselmo
	San Joaquin Delta College	Stockton
	San Jose Community College District-	
	Evergreen Valley College	San Jose
	San Jose City College	San Jose
	San Mateo County Community College	
	District-System Office	San Mateo
	Canada College	Redwood City
	College of San Mateo	San Mateo
	Skyline College	San Bruno
	Santa Ana College	Santa Ana
	Santa Barbara City College	Santa Barbara
	Santa Monica College	Santa Monica
	Santa Rosa Junior College	Santa Rosa
	Shasta College	Redding
	Sierra College	Rocklin
	Simpson College	San Francisco
	Solano Community College	Suisun City
	Southern California College	Costa Mesa
	Southern California College of Optometry	Fullerton
	Southwestern University School of Law	Los Angeles
	Stanford University	Stanford
	State Center Community College District	
	Fresno City College	Fresno
	Reedley College	Reedley
	Taft College	Taft
	United States International University	San Diego
	University of California-Berkeley	Berkeley
	University of California-Davis	Davis
	University of California Hastings College of Law	San Francisco
	University of California-Irvine	Irvine
	University of California-Los Angeles	Los Angeles
	University of California-Riverside	Riverside
	University of California-San Francisco	San Francisco
	University of California-Santa Barbara	Santa Barbara
	University of the Pacific	Stockton
	University of Redlands	Redlands
	University of San Diego	San Diego
	University of San Francisco	San Francisco
	University of Santa Clara	Santa Clara
	University of Southern California	Los Angeles
	University of West Los Angeles	Culver City
	Ventura County Community College District	
	Moorpark College	Moorpark
	Oxnard College	Oxnard
	Ventura College	Ventura
	West Coast Bible College	Fresno
	West Coast University Central Office	Los Angeles
	West Coast University Orange County Center	Orange
	Western State University College of Law-Orange County	Fullerton
	Western State University College of Law-San Diego	San Diego
	West Hills College	Coalinga
	Westmont College	Santa Barbara
	West Valley College	Saratoga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Whittier College	Whittier
	Woodbury University	Los Angeles
	The Wright Institute	Berkeley
	Yuba College	Marysville
CO	Adams State College	Alamosa
	Aims Community College	Greeley
	Arapahoe Community College	Littleton
	Colorado College	Colorado Springs
	Colorado Mountain College-East Campus	Leadville
	Colorado Mountain College-West Campus	Glenwood Springs
	Colorado School of Mines	Golden
	Colorado State University	Fort Collins
	Colorado Technical College	Manitou Springs
	Colorado Women's College	Denver
	Community College of Denver-Auraria Campus	Denver
	Community College of Denver-North Campus	Denver
	Community College of Denver-Red Rocks Campus	Golden
	Conservative Baptist Theological Seminary	Denver
	El Paso Community College	Colorado Springs
	Fort Lewis College	Durango
	Iliff School of Theology	Denver
	Lamar Community College	Lamar
	Loretto Heights College	Denver
	Mesa College	Grand Junction
	Metropolitan State College	Denver
	Morgan Community College	Fort Morgan
	Northeastern Junior College	Sterling
	Ortero Junior College	La Junta
	Regis College	Denver
	Rockmont College	Denver
	Saint Thomas Seminary	Denver
	Trinidad State Junior College	Trinidad
	University of Colorado-Boulder	Boulder
	University of Colorado-Colorado Springs	Colorado Springs
	University of Colorado-Denver	Denver
	University of Denver	Denver
	University of Denver College of Law	Denver
	University of Northern Colorado	Greeley
	University of Southern Colorado	Pueblo
	Western Bible College	Morrison
	Western State College of Colorado	Gunnison
CT	Albertus Magnus College	New Haven
	Annhurst College	Woodstock
	Bridgeport Engineering Institute	Bridgeport
	Connecticut College	New London
	Eastern Connecticut State College	Willimnatic
	Greater Hartford Community College	Hartford
	Hartford State Technical College	Hartford
	Housatonic Regional Community College	Bridgeport
	Mattuck Community College	Waterbury
	Middlesex Community College	Middletown
	Mitchell College	New London
	Mohegan Community College	Norwich
	Northwestern Connecticut Community College	Winsted
	Norwalk Community College	Norwald
	Post Junior College	Waterbury
	Quinebaug Valley Community College	Danielson
	Saint Joseph College	West Hartford

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Thames Valley State Technical College	Norwich
	Trinity College	Hartford
	Tunxis Community College	Farmington
	University of Bridgeport	Bridgeport
	University of Hartford	West Hartford
	University of New Haven	West Haven
	Yale University	New Haven
DE	Delaware State College	Dover
	Delaware Technical and Community College	Dover
	Goldey Beacom College	Wilmington
	University of Delaware	Newark
	Wesley College	Dover
DC	American University	Washington
	Catholic University of America	Washington
	District of Columbia Teachers College	Washington
	Gallaudet College	Washington
	George Washington University	Washington
	Howard University	Washington
	Mount Vernon College	Washington
	Trinity College	Washington
FL	Barry College	Miami
	Brevard Community College	Cocoa
	Broward Community College	Fort Lauderdale
	Central Florida Community College	Ocala
	Chipola Junior College	Marianna
	College of Boca Raton	Boca Raton
	Daytona Beach Community College	Daytona Beach
	Eckerd College	St. Petersburg
	Edison Community College	Fort Meyers
	Embry-Riddle Aeronautical University	Daytona Beach
	Flagler College	St. Augustine
	Florida A & M University	Tallahassee
	Florida Atlantic University	Boca Raton
	Florida College	Temple Terrace
	Florida International University	Miami
	Florida Junior College	Jacksonville
	Florida Keys Community College	Key West
	Florida Southern College	Lakeland
	Florida Technological University	Orlando
	Fort Lauderdale College	Fort Lauderdale
	Gulf Coast Community College	Panama City
	Heed University	Hollywood
	Hillsborough Community College	Tampa
	Indian River Community College	Fort Pierce
	Jacksonville University	Jacksonville
	Jones College	Jacksonville
	Lake City Community College	Lake City
	Lake-Sumter Community College	Leesburg
	Manatee Junior College	Bradenton
	Miami Christian College	Miami
	Miami-Dade Community College	Miami
	North Florida Junior College	Madison
	Nova University	Fort Lauderdale
	Okaloosa-Walton Junior College	Niceville
	Palm Beach Atlantic College	West Palm Beach
	Palm Beach Junior College	Lake Worth
	Pensacola Junior College	Pensacola
	Polk Community College	Winter Haven

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Rollins College	Winter Park
	Saint Johns River Junior College	Palatka
	Saint Leo College	Saint Leo
	Santa Fe Community College	Gainesville
	Seminole Community College	Sanford
	South-Eastern Bible College	Lakeland
	South Florida Junior College	Avon Park
	University of Florida	Gainesville
	University of Miami	Coral Gables
	University of North Florida	Jacksonville
	Warner Southern College	Lake Wales
	Webber College	Babson Park
GA	Abraham Baldwin Agricultural College	Tifton
	Agnes Scott College	Decatur
	Albany Area Vocational Technical School	Albany
	Albany Junior College	Albany
	Albany State College	Albany
	Andrew College	Cuthbert
	Armstrong State College	Savannah
	Atlanta Christian College	East Point
	Atlanta Junior College	Atlanta
	Atlanta University	Atlanta
	Augusta College	Augusta
	Bainbridge Junior College	Bainbridge
	Berry College	Mount Berry
	Brenau College	Gainesville
	Brewton-Parker College	Mount Vernon
	Carroll County Area Vocational-Technical School	Carrollton
	Carver Bible Institute and College	Atlanta
	Clark College	Atlanta
	Clayton Junior College	Morrow
	Columbus College	Columbus
	Dalton Junior College	Dalton
	DeKalb Community College	Clarkston
	Emanuel County Junior College	Swainsboro
	Emory University	Atlanta
	Fort Valley State College	Fort Valley
	Gainesville Junior College	Gainesville
	Georgia College	Milledgeville
	Georgia Institute of Technology	Atlanta
	Georgia Military College	Milledgeville
	Georgia Southern College	Statesboro
	Georgia Southwestern College	Americus
	Georgia State University	Atlanta
	Gordon Junior College	Barnesville
	Kennesaw Junior College	Marietta
	LaGrange College	LaGrange
	Macon Junior College	Macon
	Marietta-Cobb Area Vocational Technical School	Marietta
	Mercer University	Macon
	Mercer University in Atlanta	Atlanta
	Middle Georgia College	Cochran
	Morehouse College	Atlanta
	Moultrie Area Vocational-Technical School	Moultrie
	North Georgia College	Dahlonega
	North Georgia Technical and Vocational School	Clarkesville
	Oglethorpe College	Atlanta
	Pickens Area Vocational-Technical School	Jasper
	Piedmont College	Demorest
	Reinhardt College	Waleska

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Savannah Area Vocational Technical School	Savannah
	Savannah State College	Savannah
	Shorter College	Rome
	South Georgia College	Douglas
	South Georgia Technical and Vocational School	Americus
	Southern Technical Institute	Marietta
	Swainsboro Area Vocational-Technical School	Swainsboro
	Thomas Area Vocational-Technical School	Thomasville
	Tift College	Forsyth
	Toccoa Falls College	Toccoa Falls
	Troup County Area Vocational Technical School	LaGrange
	Truett McConnell College	Cleveland
	University of Georgia	Athens
	Upson County Area Vocational-Technical School	Thomaston
	Valdosta State College	Valdosta
	Valdosta Technical School	Valdosta
	Walker County Area Technical School	Rock Spring
	Waycross-Ware Area Technical School	Waycross
	Wesleyan College	Macon
	West Georgia College	Carrollton
	Young Harris College	Young Harris
HI	Brigham Young University-Hawaii Campus	Laie Oahu
	Chaminade College of Honolulu	Honolulu
	Hawaii Pacific College	Honolulu
	University of Hawaii-Honolulu Community College	Honolulu
	University of Hawaii-Kapiolani Community College	Honolulu
	University of Hawaii-Kauai Community College	Lihue
	University of Hawaii-Leeward Community College	Pearl City
	University of Hawaii-Manoa	Honolulu
	University of Hawaii-Maui Community College	Kahului
	University of Hawaii-Windward Community College	Kaneohe
ID	Boise State University	Boise
	College of Southern Idaho	Twin Falls
	Idaho State University	Pocatello
	North Idaho College	Coeur D'Alene
	Northwest Nazarene College	Nampa
	Ricks College	Rexburg
	University of Idaho	Moscow
IL	Augustana College	Rock Island
	Aurora College	Aurora
	Barat College	Lake Forest
	Belleville Area College	Belleville
	Blackburn College	Carlinville
	Black Hawk College	Moline
	Bradley University	Peoria
	Carl Sandburg College	Galesburg
	Central YMCA Community College	Chicago
	Chicago College of Osteopathic Medicine	Chicago
	Chicago State University	Chicago
	College of DuPage	Glen Ellyn

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	College of Lake County	Grayslake
	College of St. Francis	Joliet
	College of the University of Chicago	Chicago
	Danville Junior College	Danville
	DeLourdes College	Des Plaines
	DePaul University	Chicago
	DeVry Institute of Technology	Chicago
	Eastern Illinois University	Charleston
	Elgin Community College	Elgin
	Elmhurst College	Elmhurst
	Eureka College	Eureka
	George Williams College	Downers Grove
	Governors State University	Park Forest South
	Greenville College	Greenville
	Highland Community College	Freeport
	Illinois Benedictine College	Lisle
	Illinois Central College	East Peoria
	Illinois College	Jacksonville
	Illinois College of Optometry	Chicago
	Illinois College of Podiatric Medicine	Chicago
	Illinois Institute of Technology	Chicago
	Illinois State University	Normal
	Illinois Valley Community College	Oglesby
	Illinois Wesleyan University	Bloomington
	Joliet Junior College	Joliet
	Judson College	Elgin
	Kankakee Community College	Kankakee
	Kendall College	Evanston
	Kishwaukee College	Malta
	Knox College	Galesburg
	Lake Forest College	Evanston
	Lakeland College	Mattoon
	Lewis and Clark Community College	Godfrey
	Lincoln Trail College	Robinson
	Logan (John A.) College	Carterville
	Loyola University of Chicago	Chicago
	MacMurray College	Jacksonville
	McHenry County College	Crystal Lake
	McKendree College	Lebanon
	Meadville Theological School	Lombard
	Millikin University	Decatur
	Moraine Valley Community College	Palos Hills
	National College of Chiropractic	Lombard
	North Central College	Naperville
	Northeastern Illinois University	Chicago
	Northern Baptist Theological Seminary	Lombard
	Northern Illinois University	DeKalb
	Northwestern University	Evanston
	Oakton Community College	Morton Grove
	Olivet Nazarene College	Kankakee
	Olney Central College	Mt. Carmel
	Prairie State Community College	Chicago Heights
	Rockford College	Rockford
	Rock Valley College	Rockford
	Roosevelt University	Chicago
	Rush University, College of Nursing and Allied Health Sciences	Chicago
	Rush University, Rush Medical College	Chicago
	Sangamon State University	Springfield
	Sauk Valley College	Dixon
	Southern Illinois University	Carbondale
	Southern Illinois University	Edwardsville
	Spertus College of Judaica	Chicago
	Spoon River College	Canton
	Springfield College in Illinois	Springfield

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	State Community College of East Saint Louis, Illinois	East St. Louis
	Thornton Community College	South Holland
	Triton College	River Grove
	University of Health Sciences, The Chicago Medical School	Chicago
	University of Illinois at Chicago Circle	Chicago
	University of Illinois at the Medical Center, School of Public Health	Chicago
	University of Illinois at Urbana-Champaign	Urbana-Champaign
	Wabash Valley College	Mt. Carmel
	Waubonsee Community College	Sugar Grove
	Western Illinois University	Macomb
	Wheaton College	Wheaton
	William Rainey Harper College	Palatine
IN	Anderson College	Anderson
	Associated Mennonite Biblical Seminary	Elkhart
	Ball State University	Muncie
	Bethel College	Mishawaka
	Butler University	Indianapolis
	DePauw University	Greencastle
	Earlham College	Richmond
	Franklin College	Franklin
	Goshen College	Goshen
	Grace College	Winona Lake
	Hanover College	Hanover
	Holy Cross Junior College	Notre Dame
	Huntington College	Huntington
	Indiana Central College	Indianapolis
	Indiana Institute of Technology	Fort Wayne
	Indiana State University	Evansville
	Indiana University	Bloomington
	Indiana University-East	Richmond
	Indiana University-Kokomo	Kokomo
	Indiana University-Northwest	Gary
	Indiana University-South Bend	South Bend
	Indiana University-Southeast	New Albany
	Indiana University-Purdue University at Fort Wayne	Fort Wayne
	Indiana Vocational Technical College	Indianapolis
	International Junior College	Fort Wayne
	Manchester College	North Manchester
	Marian College	Indianapolis
	Marion College	Marion
	Oakland College	Oakland City
	Purdue State University	Muncie
	Purdue University	West Lafayette
	Purdue University-Calumet	Calumet
	Purdue University-North Central	Westville
	Rose-Hulman Institute of Technology	Terre Haute
	Saint Joseph's College	Rensselaer
	Saint Mary's College	Notre Dame
	Saint Mary of the Woods College	Saint Mary of the Woods
	Saint Meinard College	St. Meinard
	Taylor University	Upland
	Tri-State University	Angola
	University of Evansville	Evansville
	University of Notre Dame	South Bend
	Valparaiso University	Valparaiso
	Vincennes University	Vincennes
	Wabash College	Crawfordsville

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
IA	Area One Vocational-Technical School	Calmar and Dubuque
	Briar Cliff College	Sioux City
	Central College	Pella
	Clarke College	Dubuque
	Coe College	Cedar Rapids
	Cornell College	Mt. Vernon
	Des Moines Area Community College	Ankeny
	Drake University	Des Moines
	Ellsworth Community College	Iowa Falls
	Grinnell College	Grinnell
	Hawkeye Institute of Technology	Waterloo
	Iowa Central Community College	Fort Dodge
	Iowa Lakes Community College	Estherville
	Iowa State University	Ames
	Iowa Wesleyan College	Mount Pleasant
	Iowa Western Community College	Council Bluffs
	Kirkwood Community College	Cedar Rapids
	Loras College	Dubuque
	Luther College	Decorah
	Marshalltown Community College	Marshalltown
	Marycrest College	Davenport
	Morningside College	Sioux City
	Mount Mercy College	Cedar Rapids
	North Iowa Area Community College	Mason City
	Open Bible College	Des Moines
	Palmer College of Chiropractic	Davenport
	Simpson College	Indianola
	Southeastern Community College	Burlington
	Southwestern Community College	Creston
	University of Dubuque	Dubuque
	University of Dubuque Theological Seminary	Dubuque
	University of Iowa	Iowa City
	University of Northern Iowa	Cedar Falls
	Upper Iowa University	Fayette
	Wartburg College	Waverly
	Wartburg Seminary	Dubuque
	Westmar College	LeMars
	Western Iowa Technical Community College	Sioux City
KS	Allen County Community Junior College	Iola
	Baker University	Baldwin
	Barton County Community College	Great Bend
	Benedictine College	Atchison
	Bethel College	North Newton
	Central College	McPherson
	Cloud County Community College	Concordia
	Coffeyville Community Junior College	Coffeyville
	Colby Community College	Colby
	Cowley County Community College	Arkansas City
	Dodge City Community College	Dodge City
	Donnelly College	Kansas City
	Emporia Kansas State College	Emporia
	Fort Hays Kansas State College	Hays
	Fort Scott Community College	Fort Scott
	Friends Bible College	Haviland
	Garden City Community College	Garden City
	Haskell Indian Junior College	Lawrence
	Hesston College	Hesston
	Highland Community Junior College	Highland
	Hutchinson Community Junior College	Hutchinson
	Independence Community Junior College	Independence
	Johnson County Community College	Overland Park
	Kansas City Community College	Kansas City

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Kansas Newman College	Wichita
	Kansas State College of Pittsburg	Pittsburg
	Kansas State University	Manhattan
	Kansas Technical Institute	Salina
	Kansas Wesleyan	Salina
	Labette Community Junior College	Parsons
	Manhattan Christian College	Manhattan
	Marymount College of Kansas	Salina
	McPherson College	McPherson
	Mid-America Nazarene College	Olathe
	Neosho County Community Junior College	Chanute
	Ottawa University	Ottawa
	Pratt Community College	Pratt
	Saint John's College	Winfield
	Saint Mary College	Leavenworth
	Saint Mary of the Plains College	Dodge City
	Seward County Community College	Liberal
	Southwestern College in Kansas	Winfield
	Sterling College	Sterling
	Tabor College	Hillsboro
	The University of Kansas	Lawrence
	Washburn University of Topeka	Topeka
	Wichita State University	Wichita
KY	Alice Lloyd College	Pippa Passes
	Asbury College	Wilmore
	Bellarmine College	Louisville
	Berea College	Berea
	Brescia College	Owensboro
	Campbellsville College	Campbellsville
	Centre College of Kentucky	Danville
	Cumberland College	Williamsburg
	Eastern Kentucky University	Richmond
	Georgetown College	Georgetown
	Jefferson Vocational Regional Office	Jeffersontown
	Kentucky Christian College	Grayson
	Kentucky State University	Frankfort
	Kentucky Wesleyan College	Owensboro
	Lees Junior College	Jackson
	Lindsey Wilson College	Columbia
	Midway College	Midway
	Morehead State University	Morehead
	Murray State University	Murray
	Pikeville College	Pikeville
	Saint Catharine College	Saint Catharine
	Southeastern Christian College	Winchester
	Sue Bennett College	London
	Thomas More College	Fort Mitchell
	Transylvania University	Lexington
	University of Kentucky	Lexington
	University of Kentucky Community College System	Lexington
	University of Louisville	Louisville
	Western Kentucky University	Bowling Green
LA	Bossier Parish Community College	Bossier City
	Centenary College of Louisiana	Shreveport
	Delgado College	New Orleans
	Dillard University	New Orleans
	Grambling State University	Grambling
	Louisiana State University-Central Office	Baton Rouge

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Louisiana State University and Agricultural and Mechanical College at Baton Rouge	Baton Rouge
	Louisiana State University-Alexandria	Alexandria
	Louisiana State University-Eunice	Eunice
	Louisiana State University-Shreveport	Shreveport
	University of New Orleans	New Orleans
	Louisiana Tech University	Ruston
	McNeese State University	Lake Charles
	New Orleans Baptist Theological Seminary	New Orleans
	Northeast Louisiana University	Monroe
	Northwestern State University of Louisiana	Natchitoches
	Notre Dame Seminary School of Theology	New Orleans
	Our Lady of Holy Cross College	New Orleans
	Saint Bernard Parish Community College	Chalmette
	Saint Joseph Seminary College	Saint Benedict
	Saint Mary's Dominican College	New Orleans
	Southern University in New Orleans	New Orleans
	Tulane University of Louisiana	New Orleans
	Xavier University of Louisiana	New Orleans
ME	Bowdoin College	Brunswick
	Colby College	Waterville
	College of the Atlantic	Bar Harbor
	Eastern Maine Vocational and Technical Institute	Bangor
	Maine Maritime Academy	Castine
	Masson College	Springvale
	South Maine Vocational and Technical Institute	South Portland
	Unity College	Unity
	University of Maine at Orono	Orono
MD	Bowie State College	Bowie
	Catonsville Community College	Catonsville
	Charles County Community College	La Plata
	Chesapeake College	Wye Mills
	Columbia Union College	Takoma Park
	Community College of Baltimore	Baltimore
	Dundalk Community College	Baltimore
	Essex Community College	Baltimore County
	Garrett Community College	McHenry
	Goucher College	Towson
	Hagerstown Junior College	Hagerstown
	Harford Community College	Bel Air
	Hood College	Frederick
	Howard Community College	Columbia
	Johns Hopkins University	Baltimore
	Loyola College	Baltimore
	Montgomery College	Rockville
	Saint John's College	Annapolis
	Saint Mary's College of Maryland	Saint Mary's City
	Towson State College	Baltimore
	University of Baltimore	Baltimore
	University of Maryland	College Park
	Villa Julie College	Stevenson
	Washington College	Chestertown

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
MA	Amherst College	Amherst
	Anna Maria College	Paxton
	Assumption College	Worcester
	Bay Path Junior College	Longmeadow
	Bentley College	Waltham
	Boston College	Chestnut Hill
	Boston University	Boston
	Gordon College	Wenham
	Hampshire College	Amherst
	Harvard University	Cambridge
	Lasell Junior College	Auburndale
	Lesley College	Cambridge
	Massachusetts Institute of Technology	Cambridge
	Merrimack College	North Andover
	Mount Holyoke College	South Hadley
	Nichols College	Dudley
	Northeastern University	Boston
	Regis College	Weston
	Simon's Rock	Great Barrington
	Smith College	Northampton
	Southeastern Massachusetts University	North Darmouth
	Springfield College	Springfield
	Springfield Technical Community College	Springfield
	Stonehill College	North Easton
	Suffolk University	Boston
	Tufts University	Medford
	University of Massachusetts	Boston
	Wentworth Institute	Boston
	Wheelock College	Boston
	Williams College	Williamstown
	Worcester Junior College	Worcester
	Worcester Polytechnic Institute	Worcester
MI	Alma College	Alma
	Alpena Community College	Alpena
	Andrews University	Berrien Springs
	Aquinas College	Grand Rapids
	Bay de Noc Community College	Escanaba
	Calvin College	Grand Rapids
	Calvin Theological Seminary	Grand Rapids
	Central Michigan University	Mount Pleasant
	Concordia Lutheran Junior College	Ann Arbor
	Delta College	University Center
	Detroit Institute of Technology	Detroit
	Eastern Michigan University	Ypsilanti
	Ferris State College	Big Rapids
	General Motors Institute	Flint
	Grace Bible College	Wyoming
	Grand Rapids Baptist College	Grand Rapids
	Grand Rapids Junior College	Grand Rapids
	Grand Valley State College	Allendale
	Highland Park Community College	Highland Park
	Hillsdale College	Hillsdale
	Hope College	Holland

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Jackson Community College	Jackson
	Kalamazoo College	Kalamazoo
	Kalamazoo Valley Community College	Kalamazoo
	Kirtland Community College	Roscommon
	Lake Michigan College	Benton Harbor
	Lake Superior State College	Saulte Ste. Marie
	Lansing Community College	Lansing
	Macomb County Community College	Warren
	Madonna College	Livonia
	Marygrove College	Detroit
	Mercy College of Detroit	Detroit
	Merrill-Palmer Institute	Detroit
	Michigan Department of Education-Environmental Guidelines	Lansing
	Michigan State University	East Lansing
	Michigan Technological University	Houghton
	Mid Michigan Community College	Harrison
	Monroe County Community College	Monroe
	Montcalm Community College	Sidney
	Mott Community College	Flint
	Muskegon Business College	Muskegon
	Muskegon Community College	Muskegon
	Northern Michigan University	Marquette
	Northwestern Michigan College	Traverse City
	Oakland Community College	Bloomfield Hills
	Oakland University	Rochester
	Olivet College	Olivet
	Saginaw Valley State College	University Center
	Saint Mary's College	Orchard Lake
	Schoolcraft College	Livonia
	Shaw College at Detroit	Detroit
	Southwestern Michigan College	Dowagiac
	Spring Arbor College	Spring Arbor
	Suomi College	Hancock
	University of Detroit	Detroit
	University of Michigan	Ann Arbor
	Walsh College	Troy
	Washtenaw Community College	Ann Arbor
	Wayne County Community College	Detroit
	Wayne State University	Detroit
	Western Michigan University	Kalamazoo
	West Shore Community College	Scottville
	Western Theological Seminary	Holland
MN	Anoka-Ramsey Community College	Coon Rapids
	Augsburg College	Minneapolis
	Austin Community College	Austin
	Bemidji State University	Bemidji
	Bethany Lutheran College	Mankato
	Brainerd Community College	Brainerd
	Carleton College	Northfield
	College of Saint Benedict	St. Joseph
	College of St. Catherine	St. Paul
	College of St. Scholastica	Duluth
	College of St. Thomas	St. Paul
	Concordia College	Moorhead
	Crosier Seminary Junior College	Onamia
	Dr. Martin Luther College	New Ulm
	Fergus Falls Community College	Fergus Falls
	Hibbing Community College	Hibbing
	Itasca Community College	Grand Rapids
	Lakewood Community College	White Bear Lake
	Luther Theological Seminary	St. Paul
	Macalester College	St. Paul
	Mankato State University	Mankato

APPENDIX V
CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Mesabi Community College	Virginia
	Metropolitan Community College	Minneapolis
	Metropolitan State University	St. Paul
	Minneapolis College of Art and Design	Minneapolis
	Minnesota Bible College	Rochester
	Moorhead State College	Moorhead
	Normandale Community College	Bloomington
	North Hennepin Community College	Minneapolis
	Northland Community College	Thief River Falls
	Northwestern College	Roseville
	Rainy River Community College	International Falls
	Rochester Community College	Rochester
	Saint John's University	Collegeville
	Saint Mary's College	Winona
	Southwest Minnesota State College	Marshall
	St. Cloud Area Vocational Technical Institute	St. Cloud
	St. Cloud State University	St. Cloud
	St. Mary's Junior College	Minneapolis
	St. Paul Bible College	Bible College
	United Theological Seminary of the Twin Cities	New Brighton
	University of Minnesota	Minneapolis
	Vermilion Community College	Ely
	William Mitchell College of Law	St. Paul
	Winona State University	Winona
	Worthington Community College	Worthington
MS	Alcorn State University	Lorman
	Belhaven College	Jackson
	Clarke College	Newton
	Coahama Junior College	Clarksdale
	Copiah-Lincoln Junior College	Wesson
	Delta State University	Cleveland
	East Central Junior College	Decatur
	East Mississippi Junior College	Scooba
	Hinds Junior College	Raymond
	Holmes Junior College	Goodman
	Itawamba Junior College	Fulton
	Jackson State University	Jackson
	John C. Stennis Vocational Complex	Dekalb
	Jones County Junior College	Ellisville
	Mary Holmes College	West Point
	Meridian Junior College	Meridian
	Millsaps College	Jackson
	Mississippi College	Clinton
	Mississippi Delta Junior College	Moorhead
	Mississippi Gulf Coast Junior College	Perkinston
	Mississippi Industrial College	Holly Springs
	Mississippi State University	Mississippi State
	Mississippi University for Women	Columbus
	Northeast Mississippi Junior College	Booneville
	Northwest Mississippi Junior College	Senatobia
	Pearl River Junior College	Poplarville
	Rust College	Holly Springs
	Southwest Mississippi Junior College	Summit
	Tougaloo College	Tougaloo
	University of Mississippi	University
	University of Mississippi Medical Center	Jackson
	University of Southern Mississippi	Hattiesburg
	Utica Junior College	Utica
	Wesley College	Florence
	William Carey College	Hattiesburg
	Wood Junior College	Mathiston

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
MO	Assemblies of God Graduate School	Springfield
	Avila College	Kansas City
	Calvary Bible College	Kansas City
	Central Bible College	Springfield
	Central Methodist College	Fayette
	Central Missouri State University	Warrensburg
	Columbia College	Columbia
	Concordia Seminary	St. Louis
	Cottey College	Nevada
	Crowder College	Neosho
	Culver-Stockton College	Canton
	Fontbonne College	St. Louis
	Hannibal Lagrange College	Hannibal
	Harris Teachers College	St. Louis
	Jefferson College	Hillsboro
	Kansas City Art Institute	Kansas City
	Kansas City College of Osteopathic Medicine	Kansas City
	Logan College of Chiropractic	Chesterfield
	Longview Community College	Kansas City
	Maple Woods Community College	Kansas City
	Maryville College	St. Louis
	Meramec Community College	St. Louis
	Missouri Baptist College	St. Louis
	Missouri Southern State College	Joplin
	Moberly Area Junior College	Moberly
	Northeast Missouri State University	Kirksville
	Northwest Missouri State University	Maryville
	Rockhurst College	Kansas City
	Saint Louis College of Pharmacy	St. Louis
	Saint Louis Community College at Forest Park	St. Louis
	Saint Louis University	St. Louis
	Saint Paul's College	Concordia
	School of the Ozarks	Point Lookout
	Southwest Missouri State University	Springfield
	State Fair Community College	Sedalia
	Stephen's College	Columbia
	Tarkio College	Tarkio
	The Principia	St. Louis
	Three Rivers Community College	Poplar Bluff
	University of Missouri-Columbia	Columbia
	University of Missouri-Kansas City	Kansas City
	University of Missouri-Rolla	Rolla
	University of Missouri-St. Louis	St. Louis
	Washington University	St. Louis
	Water and Wastewater Technical School	Neosho
	Webster College	Webster
	Westminster College	Fulton
	William Jewell College	Kansas City
MT	Carroll College	Helena
	College of Great Falls	Great Falls
	Dawson College	Glendive
	Eastern Montana College	Billings
	Flathead Valley Community College	Kalispell
	Miles Community College	Miles City
	Montana College of Mineral Science and Technology	Butte
	Montana State University	Bozeman
	Northern Montana College	Havre
	Rocky Mountain College	Billings
	University of Montana	Missoula
	Western Montana College	Dillon

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
NE	Central Technical Community College	Hastings
	Chadron State College	Chadron
	College of Saint Mary	Omaha
	Concordia College	Seward
	Creighton University	Omaha
	Dana College	Blair
	Doane College	Crete
	Grace College of the Bible	Omaha
	Hastings College	Hastings
	Kearney State College	Kearney
	McCook Community College	McCook
	Midland Lutheran College	Fremont
	Mid-Plains Community College	North Platte
	Northeast Technical Community College	Norfolk
	Platte Technical Community College	Columbus
	Southeast Community College	Lincoln
	Union College	Lincoln
	University of Mid-America	Lincoln
	University of Nebraska	Lincoln
	Wayne State College	Wayne
NV	University of Nevada-Las Vegas	Las Vegas
	University of Nevada-Reno	Reno
	Clark County Community College	Las Vegas
	Northern Nevada Community College	Elko
	Sierra Nevada College	Incline Village
	Western Nevada Community College	Carson City
NH	Colby-Sawyer College	New London
	Dartmouth College	Hanover
	Franklin Pierce College	Rindge
	New England College	Henniker
	NH Technical Institute	Concord
	NH Voc-Tech College of Berlin	Berlin
	NH Voc-Tech College of Claremont	Claremont
	NH Voc-Tech College of Laconia	Laconia
	NH Voc-Tech College of Manchester	Manchester
	NH Voc-Tech College of Nashua	Nashua
	NH Voc-Tech College of Portsmouth	Portsmouth
	Saint Anselm's College	Manchester
	University of New Hampshire	Durham
	White Pines College	Chester
NJ	Atlantic Community College	Mays Landing
	Bergen Community College	Paramus
	Brookdale Community College	Lincroft
	Burlington County College	Penberton
	Camden County College	Caldwell
	Centenary College for Women	Hackettstown
	County College of Morris	Dover
	Cumberland County College	Vineland
	Drew University	Madison
	Fairleigh Dickinson University	Rutherford
	Gloucester County College	Sewell
	Kean College of New Jersey	Union
	Mercer County Community College	Trenton
	Middlesex County College	Edison
	Montclair State College	Upper Montclair
	New Jersey Institute of Technology	Newark
	Ocean County College	Toms River
	Passaic County Community College	Paterson
	Princeton University	Princeton

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Rider College	Trenton
	Rutgers the State University	New Brunswick
	Stevens Institute of Technology	Hoboken
	Trenton State College	Trenton
	Union College	Cranford
	Union County Technical Institute	Scotch Plains
	William Paterson College	Wayne
NM	College of the Southwest	Hobbs
	Eastern New Mexico University-Main Campus	Portales
	Eastern New Mexico University-Roswell	Roswell
	New Mexico Highlands University	Las Vegas
	New Mexico Institute of Mining and Technology	Socorro
	New Mexico Junior College	Hobbs
	New Mexico Military Institute	Roswell
	New Mexico State University-Las Cruces	Las Cruces
	New Mexico State University-San Juan	San Juan
	University of Albuquerque	Albuquerque
	University of New Mexico-Main Campus	Albuquerque
NY	Adelphi University	Garden City
	Albany College Pharmacy	Albany
	Albany Law School	Albany
	Alfred University	Alfred
	Bard College	Annandale-on-Hudson
	Bronx Community College	Bronx
	Brooklyn Law School	Brooklyn
	Canisius	Buffalo
	City University of New York	New York
	Clarkson College of Technology	Potsdam
	Colgate University	Hamilton
	College of Mt. Saint Vincent	Riverdale
	College of Saint Rose	Albany
	Columbia University	New York
	Concordia College	Bronxfille
	Cornell University	Ithaca
	Dowling College	Oakdale Long Island
	D'Youville College	Buffalo
	Erie Community College	Buffalo
	Hamilton College	Clinton
	Hartwick College	Oneonta
	Hilbert College	Hamburg
	Hobart-William Smith Colleges	Geneva
	Hofstra University	Hempstead
	Houghton College	Houghton
	Hudson Valley Community College	Troy
	Hunter College	New York
	Ithaca College	Ithaca
	King's College	Briarcliff Manor
	Long Island University	Greenvale
	Manhattan College	Bronx
	Medaille College	Buffalo
	Mercy College	Dobbs Ferry
	Molloy College	Rockville Centre
	New School for Social Research	New York
	New York Institute of Technology	Old Westbury
	New York Law School	New York
	Niagara University	Niagara University

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Paul Smith's College of Arts & Science	Paul Smiths
	Polytechnic Institute of New York	Brooklyn
	Rensselaer Polytechnic Institute	Troy
	Roberts Wesleyan College	Rochester
	Rochester Institute of Technology	Rochester
	Rockefeller University	New York
	Saint Banaventure University	Saint Bonaventure
	Saint John Fisher College	Rochester
	Saint John's University	Jamaica
	Saint Lawrence University	Canton
	Saint Thomas Aquinas College	Sparkhill
	Skidmore College	Saratoga Springs
	Southampton College	Southampton
	State University of New York at Buffalo	Buffalo
	Syracuse University	Syracuse
	The Cooper Union	New York
	Trocaire College	Buffalo
	Ulster County Community College	Stone Ridge
	University of Rochester	Rochester
	Vassar College	Poughkeepsie
	Wagner College	Staten Island
	Webb Institute of Naval Architecture	Glen Cove
	Westchester Community College	Valhalla
NC	Anson Technical Institute	Ansonville
	Appalachian State University	Boone
	Asheville Buncombe Technical Institute	Asheville
	Atlantic Christian College	Wilson
	Beaufort County Technical Institute	Washington
	Belmont Abbey College	Belmont
	Bennett College	Greensboro
	Bladen Technical Institute	Dublin
	Blue Ridge Technical Institute	Flat Rock
	Brevard College	Brevard
	Campbell College	Buies Creek
	Cape Fear Technical Institute	Wilmington
	Carteret Technical Institute	Morehead City
	Catawba College	Salisbury
	Catawba Valley Technical Institute	Hickory
	Central Carolina Technical Institute	Sanford
	Central Piedmont Community College	Charlotte
	Chowan College	Murfreesboro
	Cleveland County Technical Institute	Shelby
	Coastal Carolina Community College	Jacksonville
	College of the Albemarle	Elizabeth City
	Craven Community College	New Bern
	Davidson College	Davidson
	Davidson County Community College	Lexington
	Duke University	Durham
	Durham College	Durham
	East Carolina University	Greenville
	Elon College	Elon College
	Fayetteville State University	Fayetteville
	Fayetteville Technical Institute	Fayetteville
	Gardner Webb College	Boiling Springs
	Gaston College	Dallas
	Greensboro College	Greensboro
	Guilford College	Greensboro
	Guilford Technical Institute	Jamestown
	Halifax Community College	Weldon
	Haywood Technical Institute	Clyde
	High Point College	High Point
	Isothermal Community College	Spindale
	James Sprunt Institute	Kenansville
	Johnson C. Smith University	Charlotte

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Johnston Technical Institute	Smithfield
	Lees-McCrae College	Banner Elk
	Lenoir Community College	Kinston
	Lenoir-Rhyne College	Hickory
	Livingstone College	Salisbury
	Louisburg College	Louisburg
	Mars Hill College	Mars Hill
	Martin Community College	Williamston
	Mayland Technical Institute	Spruce Pine
	McDowell Technical Institute	Marion
	Meredith College	Raleigh
	Methodist College	Fayetteville
	Montreat-Anderson College	Montreat
	Mount Olive College	Mount Olive
	Nash Technical Institute	Rocky Mount
	North Carolina Agricultural and Technical State University	Greensboro
	North Carolina Central University	Durham
	North Carolina State University	Raleigh
	North Carolina Wesleyan College	Rocky Mount
	Pembroke State University	Pembroke
	Pfeiffer College	Misenheimer
	Piedmont Bible College	Winston-Salem
	Piedmont Technical Institute	Roxboro
	Pitt Technical Institute	Greenville
	Queens College	Charlotte
	Randolph Technical Institute	Asheboro
	Richmond Technical Institute	Hamlet
	Roanoke-Chowan Technical Institute	Ahoskie
	Robeson Technical Institute	Lumberton
	Rockingham Community College	Wentworth
	Rowan Technical Institute	Salisbury
	Saint Andrews Presbyterian College	Laurinburg
	Saint Augustine's College	Raleigh
	Saint Mary's College	Raleigh
	Salem College	Winston-Salem
	Sampson Technical Institute	Clinton
	Sandhills Community College	Carthage
	Shaw University	Raleigh
	Stanly Technical Institute	Albermarle
	Surry Community College	Dobson
	Technical Institute of Alamance	Burlington
	Tri-County Technical Institute	Murphy
	University of North Carolina at Chapel Hill	Chapel Hill
	University of North Carolina at Charlotte	Charlotte
	University of North Carolina at Greensboro	Greensboro
	University of North Carolina at Wilmington	Wilmington
	Wake Forest University	Winston-Salem
	Wake Technical Institute	Raleigh
	Warren Wilson College	Swannanoa
	Wayne Community College	Goldsboro
	Western Carolina University	Cullowhee
	Western Piedmont Community College	Morganton
	Wilkes Community College	Wilkesboro
	Wilson County Technical Institute	Wilson
	Wingate College	Wingate
	Winston-Salem State University	Winston-Salem

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
ND	Bismarck Junior College	Bismarck
	Dickinson State College	Dickinson
	Jamestown College	Jamestown
	Lake Region Junior College	Devils Lake
	Mary College	Bismarck
	Mayville State College	Mayville
	Minot State College	Minot
	North Dakota State School of Science	Wahpeton
	North Dakota State University-Main Campus	Fargo
	North Dakota State University-Bottineau	Bottineau
	Trinity Bible Institute	Ellendale
	University of North Dakota-Main Campus	Grand Forks
	University of North Dakota-Williston	Williston
OH	Antioch College	Yellow Springs
	Art Academy of Cincinnati	Cincinnati
	Bluffton College	Bluffton
	Capital University	Columbus
	Case Western Reserve University	Cleveland
	Central Ohio Technical College	Newark
	Central State University	Wilberforce
	Cincinnati Bible College	Cincinnati
	Cincinnati Technical College	Cincinnati
	Clark Technical College	Springfield
	Cleveland Institute of Art	Cleveland
	Cleveland Institute of Music	Cleveland
	Cleveland State University	Cleveland
	College of Mount St. Joseph on the Ohio	Cincinnati
	College of Steubenville	Steubenville
	College of Wooster	Wooster
	Columbus College of Art and Design	Columbus
	Columbus Technical Institute	Columbus
	Cuyahoga Community College	Cleveland
	Davis Junior College	Toledo
	Defiance College	Defiance
	Denison University	Granville
	Franklin University	Columbus
	Hebrew Union College	Cincinnati
	Heidelberg College	Tiffin
	Hiram College	Hiram
	Hocking Technical College	Nelsonville
	Jefferson County Technical Institute	Steubenville
	John Carroll University	Cleveland
	Josephinum College of Liberal Arts	Worthington
	Kent State University	Kent
	Kenyon College	Gambier
	Kettering College of Medical Arts	Kettering
	Lakeland Community College	Mentor
	Lima Technical College	Lima
	Lorain County Community College	Elyria
	Lutheran Theological Seminary	Columbus
	Malone College	Canton
	Marietta College	Marietta
	Marion Technical College	Marion
	Medical College of Ohio	Toledo
	Miami-Jacobs Junior College	Dayton
	Miami University	Oxford
	Mount Union College	Alliance
	Mount Vernon Nazarene College	Mount Vernon
	Muskingum Area Technical College	Zanesville
	Muskingum College	New Concord
	National Training and Operational Technology Center (EPA)	Cincinnati
	North Central Technical College	Mansfield

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Northwest Technical College	Archbold
	Notre Dame College	Cleveland
	Oberlin College	Oberlin
	Ohio Board of Regents-Technical Education Offerings	Columbus
	Ohio Dominican College	Columbus
	Ohio Northern University	Ada
	Ohio State University	Columbus
	Ohio University	Athens
	Ohio Wesleyan University	Delaware
	Owens Technical College	Perrysburg
	Saint John College of Cleveland	Cleveland
	Sinclair Community College	Dayton
	Stark Technical College	Canton
	Tiffin University	Tiffin
	United Theological Seminary	Dayton
	University of Cincinnati	Cincinnati
	University of Dayton	Dayton
	University of Toledo	Toledo
	Urbana College	Urbana
	Washington Technical College	Marietta
	Wittenberg University	Springfield
	Wright State University	Dayton
	Xavier University	Cincinnati
	Youngstown State University	Youngstown
OK	Bacone College	Muskogee
	Bartlesville Weslyan College	Bartlesville
	Bethany Nazarene College	Bethany
	Cameron University	Lawton
	Carl Albert Junior College	Poteau
	Central State University	Edmond
	Claremore Junior College	Claremore
	Connors State College	Warner
	East Central Oklahoma State University	Ada
	Eastern Oklahoma State College	Wilburton
	El Reno Junior College	El Reno
	Hillsdale Free Will Baptist College	Moore
	Midwest Christian College	Oklahoma City
	Murray State College	Tishomingo
	Northeastern Oklahoma Agricultural and Mechanical College	Miami
	Northeastern Oklahoma State University	Tahlequah
	Northern Oklahoma College	Tonkawa
	Northwesterm Oklahoma State University	Alva
	Oklahoma Baptist University	Shawnee
	Oklahoma Christian College	Oklahoma City
	Oklahoma City University	Oklahoma City
	Oklahoma Panhandle State University	Goodwell
	Oklahoma School of Business, Accountancy, Law and Finance	Tulsa
	Oklahoma State University-Main Campus	Stillwater
	Oklahoma State University-Oklahoma City	Oklahoma City
	Oral Roberts University	Tulsa
	Oscar Rose Junior College	Midwest City
	Phillips University	Enid
	Saint Gregory's College	Shawnee
	Sayre Junior College	Sayre
	Seminole Junior College	Seminole
	Southeastern Oklahoma State University	Durant
	South Oklahoma City Junior College	Oklahoma City
	Southwestern College	Oklahoma City
	Tulsa Junior College	Tulsa
	University of Oklahoma-Central Office	Norman

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	University of Oklahoma-Health Science Center	Oklahoma City
	University of Science and Arts of Oklahoma	Chickasha
	University of Tulsa	Tulsa
	Western Oklahoma State College	Altus
OR	Blue Mountain Community College	Pendleton
	Chemeketa Community College	Salem
	Clackamas Community College	Oregon City
	Clatsop Community College	Astoria
	Columbia Christian College	Portland
	Concordia College	Portland
	George Fox College	Newberg
	Judson Baptist College	Portland
	Lane Community College	Eugene
	Lewis and Clark College	Portland
	Linfield College	McMinnville
	Linn-Benton Community College	Albany
	Marylhurst Education Center	Marylhurst
	Mount Hood Community College	Gresham
	Multnomah School of the Bible	Portland
	Museum Art School	Portland
	Oregon State Higher Education District	
	Eastern Oregon State College	La Grande
	Oregon College of Education	Monmouth
	Oregon Institute of Technology	Klamath Falls
	Oregon State University	Corvallis
	Portland State University	Portland
	Southern Oregon State College	Ashland
	University of Oregon-Health Sciences Center	Portland
	Pacific University	Forest Grove
	Reed College	Portland
	Southwestern Oregon Community College	Coos Bay
	Treasure Valley Community College	Ontario
	Umpqua Community College	Rosenburg
	University of Portland	Portland
	Warner Pacific College	Portland
	Western Baptist Bible College	Salem
	Western Conservative Baptist Seminary	Portland
	Western Evangelical Seminary	Portland
	Williamette University	Salem
PA	Allegheny College	Meadville
	Allentown College of St. Francis De Sales	Center Valley
	Alliance College	Cambridge Springs
	Beaver College	Glenside
	Bloomsburg State College	Bloomsburg
	Bucks County Community College	Newton
	Butler County Community College	Butler
	Cabrini College	Radnor
	California State College	California
	Carlow College	Pittsburgh
	Carnegie-Mellon University	Pittsburgh
	Cedar Crest College	Allentown
	Chestnut Hill College	Philadelphia
	Cheyney State College	Cheyney
	Clarion State College	Clarion
	Community College of Allegheny County	Pittsburgh
	Community College of Beaver County	Monaca
	Community College of Philadelphia	Philadelphia
	Delaware Valley College of Science and Agriculture	Doylestown

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Dickinson College	Carlisle
	Drexel University	Philadelphia
	The Dropsie University	Philadelphia
	Duquesne University	Pittsburgh
	Eastern College	Saint Davids
	East Stroudsburg State College	East Stroudsburg
	Edinboro State College	Edinboro
	Franklin-Marshall College	Lancaster
	Gannon College	Erie
	Geneva College	Beaver Falls
	Gettysburg College	Gettysburg
	Gwynedd-Mercy College	Gwynedd Valley
	Harcum Junior College	Bryn Mawr
	Haverford College	Haverford
	Indiana University of Pennsylvania	Indiana
	Juniata College	Huntingdon
	Keystone Junior College	La Plume
	King's College	Wilkes-Barre
	Lafayette College	Easton
	La Roche College	Allison Park
	La Salle College	Philadelphia
	Lehigh University	Bethlehem
	Lincoln University	Lincoln University
	Lock Haven State College	Lock Haven
	Lycoming College	Williamsport
	Mansfield State College	Mansfield
	Marywood College	Scranton
	Mercyhurst College	Erie
	Millersville State College	Millersville
	Montgomery County Community College	Blue Bell
	Northeastern Christian Junior College	Villanova
	Pennsylvania State University	University Park
	Philadelphia College of Pharmacy and Science	Philadelphia
	Point Park College	Pittsburgh
	Reading Area Community College	Reading
	Saint Fidelis College	Herman
	Saint Francis College	Loretto
	Saint Joseph's College	Philadelphia
	Saint Vincent College	Latrobe
	Seton Hill College	Greensburg
	Slippery Rock State College	Slippery Rock
	Spring Garden College	Chestnut Hill
	Susquehanna University	Selinsgrove
	Swarthmore College	Swarthmore
	Temple University	Philadelphia
	University of Pennsylvania	Philadelphia
	University of Pittsburg	Pittsburgh
	University of Scranton	Scranton
	Ursinus College	Collegeville
	Villa Maria College	Erie
	Villanova University	Villanova
	Waynesburg College	Waynesburg
	West Chester State College	West Chester
	Westminster College	New Wilmington
	Widener College	Chester
	Wilkes College	Wilkes-Barre
	Williamsport Area Community College	Williamsport
	Wilson College	Chambersburg
PR	Inter American University of Puerto Rico	San German
	The Catholic University of Puerto Rico	Ponce
	University of Puerto Rico	Mayaguez
	University of Puerto Rico	Rio Pedras

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
RI	Brown University	Providence
	Providence College	Providence
	Roger Williams College	Bristol
	University of Rhode Island	Kingston
SC	Aiken Technical Education Center	Aiken
	Baptist College	Charleston
	Bob Jones University	Greenville
	Central Wesleyan College	Central
	Citadel Military College of South Carolina	Charleston
	Claflin College	Orangeburg
	Clemson University	Clemson
	Coastal Carolina College	Conway
	Coker College	Hartsville
	College of Charleston	Charleston
	Columbia College	Columbia
	Columbia Bible College	Columbia
	Converse College	Spartanburg
	Erskine College	Due West
	Florence-Darlington Technical College	Florence
	Francis Marion College	Florence
	Furman University	Greenville
	Greenville Technical College	Greenville
	Lander College	Greenwood
	Limestone College	Gaffney
	Morris College	Sumter
	Newberry College	Newberry
	North Greenville College	Tigerville
	Orangeburg-Calhoun Technical College	Orangeburg
	Piedmont Technical College	Greenwood
	South Carolina State College	Orangeburg
	Sumter Area Technical College	Sumter
	Tri County Technical College	Pendleton
	Trident Technical College	North Charleston
	University of South Carolina	Columbia
	University of South Carolina at Aiken	Aiken
	University of South Carolina at Beaufort	Beaufort
	University of South Carolina at Spartanburg	Spartanburg
	University of South Carolina at Union	Union
	Voorhees College	Denmark
	Winthrop College	Rock Hill
	Wofford College	Spartanburg
SD	Augustana College	Sioux Falls
	Black Hills State College	Spearfish
	Dakota Wesleyan University	Mitchell
	Freeman Junior College	Freeman
	National College of Business	Rapid City
	Northern State College	Aberdeen
	Presentation College	Aberdeen
	Sioux Falls College	Sioux Falls
	South Dakota School of Mines and Technology	Rapid City
	South Dakota State University	Brookings
	University of South Dakota-Springfield	Springfield
TN	Aquinas Junior College	Nashville
	Austin Peay State University	Clarksville
	Belmont College	Nashville
	Carson-Newman College	Jefferson City
	Chattanooga State Technical Community College	Chattanooga

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Christian Brothers College	Memphis
	Cleveland State Community College	Cleveland
	Columbia State Community College	Columbia
	Covenant College	Lookout Mountain
	Cumberland College	Lebanon
	David Lipscomb College	Nashville
	Dyersburg State Community College	Dyersburg
	East Tennessee State University	Johnson City
	Fisk University	Nashville
	Freed-Hardeman College	Henderson
	Free Will Baptist Bible College	Nashville
	George Peabody College for Teachers	Nashville
	Hiwassee College	Madisonville
	Jackson State Community College	Jackson
	King College	Bristol
	Knoxville College	Knoxville
	Lambuth College	Jackson
	LeMoyne-Owen College	Memphis
	Martin College	Pulaski
	Memphis State University	Memphis
	Middle Tennessee State University	Murfreesboro
	Milligan College	Milligan College
	Nashville State Technical Institute	Nashville
	Roane State Community College	Harriman
	Shelby State Community College	Memphis
	State Technical Institute at Memphis	Memphis
	Steed College	Johnson City
	Tennessee Technological University	Cookeville
	Tennessee Wesleyan College	Athens
	University of the South	Sewanee
	University of Tennessee	Knoxville
	University of Tennessee Center for Health Sciences	Memphis
	University of Tennessee at Martin	Martin
	University of Tennessee at Nashville	Nashville
	Vanderbilt University	Nashville
	Volunteer State Community College	Gallatin
	Walters State Community College	Morristown
TX	Abilene Christian University	Abilene
	Alvin Community College	Alvin
	Amarillo College	Amarillo
	American Technological University	Killeen
	Angelina College	Lufkin
	Angelo State University	San Angelo
	Austin College	Sherman
	Austin Presbyterian Technological Seminary	Austin
	Baylor College of Dentistry	Dallas
	Baylor College of Medicine	Houston
	Baylor University	Waco
	Bee County College	Beeville
	Blinn College	Brenham
	Brazosport College	Lake Jackson
	Cisco Junior College	Cisco
	Clarendon College	Clarendon
	College of the Mainland	Texas City
	Concordia Lutheran College	Austin
	Cooke County College	Gainesville
	Dallas Bible College	Dallas
	Dallas Christian College	Dallas
	Dallas County Community College District	
	Eastfield College	Mesquite
	El Centro College	Dallas
	Mountain View College	Dallas
	Richland College	Dallas

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Dallas Theological Seminary	Dallas
	Del Mar College	Corpus Christi
	DeVry Institute of Technology	Dallas
	East Texas Baptist College	Marshall
	East Texas State University	Commerce
	El Paso Community College	El Paso
	Frank Phillips College	Borger
	Galveston College	Galveston
	Grayson College	Denison
	Gulf Coast Bible College	Houston
	Hardin-Simmons University	Abilene
	Henderson County Junior College	Athens
	Houston Baptist University	Houston
	Houston Community College	Houston
	Howard College at Big Spring	Big Spring
	Howard Payne University	Brownwood
	Huston-Tillotson College	Austin
	Incarnate Word College	San Antonio
	Jacksonville College	Jacksonville
	Jarvis Christian College	Hawkins
	Kilgore College	Kilgore
	Lamar University	Beaumont
	Laredo Junior College	Laredo
	Lee College	Baytown
	Le Tourneau College	Longview
	Lon Morris College	Jacksonville
	Lubbock Christian College	Lubbock
	McLennan Community College	Waco
	McMurry College	Abilene
	Midland College	Midland
	Midwestern State University	Wichita Falls
	Navarro College	Corsicana
	North Harris County College	Houston
	North Texas State University	Denton
	Odessa College	Odessa
	Our Lady of the Lake University of San Antonio	San Antonio
	Pan American University	Edinburg
	Panola Junior College	Carthage
	Ranger Junior College	Ranger
	Rice University	Houston
	Saint Edward's University	Austin
	Sam Houston State University	Huntsville
	San Antonio College	San Antonio
	San Jacinto College	Pasadena
	Schreiner College	Kerrville
	Southern Bible College	Houston
	Southern Methodist University	Dallas
	South Plains College	Levelland
	South Texas College of Law	Houston
	Southwestern Assemblies of God College	Waxahachie
	Southwestern Baptist Theological Seminary	Fort Worth
	Southwestern Christian College	Terrell
	Southwestern Union College	Keene
	Southwestern University	Georgetown
	Southwest Texas State University	San Marcos
	Stephen F. Austin State University	Nacogdoches
	Tarleton State University	Stephenville
	Tarrant County Junior College-Northeast Campus	Hurst
	Tarrant County Junior College-Northwest Campus	Fort Worth
	Tarrant County Junior College-South Campus	Fort Worth
	Texarkana College	Texarkana
	Texas A & I University	Kingsville

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Texas A & I University-Corpus Christi	Corpus Christi
	Texas A & I University-Laredo	Laredo
	Texas A & M University-Main Campus	College Station
	Texas A & M University Moody College of Marine Sciences and Maritime Resources	Galveston
	Texas Christian University	Fort Worth
	Texas College	Tyler
	Texas Lutheran College	Seguin
	Texas Southmost College	Brownsville
	Texas State Technical Institute-James Connally Campus	Waco
	Texas State Technical Institute-Mid-Continent Campus	Amarillo
	Texas State Technical Institute-Rio Grande Campus	Harlingen
	Texas Tech University	Lubbock
	Texas Wesleyan College	Fort Worth
	Texas Woman's University	Denton
	Trinity University	San Antonio
	Tyler Junior College	Tyler
	University of Dallas	Irving
	University of Houston-Main Campus	Houston
	University of Houston-Clear Lake City	Houston
	University of Houston-Victoria Campus	Victoria
	University of Texas-Arlington	Arlington
	University of Texas-Austin	Austin
	University of Texas at Dallas	Richardson
	University of Texas-El Paso	El Paso
	University of Texas Health Science Center at Dallas	Dallas
	University of Texas Health Science Center at Houston	Houston
	University of Texas Medical Branch at Galveston	Galveston
	University of Texas-San Antonio	San Antonio
	Vernon Regional Junior College	Vernon
	Victoria College	Victoria
	Weatherford College	Weatherford
	Western Texas College	Snyder
	West Texas State Universtiy	Canyon
	Wharton County Junior College	Wharton
	Wiley College	Marshall
UT	Brigham Young University	Provo
	Stevens Henager College	Ogden
	University of Utah	Salt Lake City
	Utah Higher Education System Office	
	University of Utah	Salt Lake City
	Utah State University	Logan
	Southern Utah State College	Cedar City
	Weber State College	Ogden
	College of Eastern Utah	Price
	Dixie College	Saint George
	Snow College	Ephraim
	Utah Technical College at Salt Lake City	Salt Lake City
	Westminster College	Salt Lake City

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
VT	Champlain College	Burlington
	Johnson State College	Johnson
	Lyndon State College	Lyndonville
	Marlboro College	Marlboro
	Middlebury College	Middlebury
	Norwich University	Northfield
	Saint Michael's College	Winooski
	School for International Training	Brattleboro
	Southern Vermont College	Bennington
	Trinity College	Burlington
	University of Vermont and State Agriculture College	Burlington
	Vermont Institute of Community Involvement	South Burlington
	Vermont Technical College	Randolph Center
	Windham College	Putney
VA	Averett College	Danville
	Bridgewater College	Bridgewater
	College of William and Mary	Williamsburg
	Eastern Mennonite College	Harrisonburg
	Eastern Virginia Medical School	Norfolk
	Emory and Henry College	Emory
	Ferrum College	Ferrum
	Hampton Institute	Hampton
	Institute of Textile Technology	Charlottesville
	J. Sargeant Reynolds Community College	Richmond
	Madison University	Harrisonburg
	Old Dominion University	Norfolk
	Radford College	Radford
	Randolph-Macon College	Ashland
	Randolph-Macon Woman's College	Lynchburg
	Saint Paul's College	Lawrenceville
	University of Virginia	Charlottesville
	Virginia Intermont College	Bristol
	Virginia Military Institute	Lexington
	Virginia Polytechnic Institute and State University	Blacksburg
	Virginia Wesleyan College	Norfolk
	Washington and Lee University	Lexington
	Wytheville Community College	Wytheville
WA	Bellevue Community College	Bellevue
	Big Bend Community College	Moses Lake
	Centralia College	Centralia
	Central Washington State College	Ellensburg
	Clark College	Vancouver
	Columbia Basin Community College	Pasco
	Cornish School of Allied Arts	Seattle
	Eastern Washington State College	Cheney
	Evergreen State College	Olympia
	Fort Steilacoom Community College	Tacoma
	Fort Wright College of the Holy Names	Spokane
	Gonzaga University	Spokane
	Grays Harbor College	Aberdeen
	Green River Community College	Auburn
	Highline Community College	Midway
	Lower Columbia College	Longview
	Lutheran Bible Institute of Seattle	Seattle
	Northwest College of the Assemblies of God	Kirkland
	Olympia Technical Community College	Olympia
	Olympic College	Bremerton
	Pacific Lutheran University	Tacoma
	Peninsula College	Port Angeles

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Seattle Community College District	
	North Seattle Community College	Seattle
	Seattle Community College-Central Campus	Seattle
	Seattle Community College-South Campus	Seattle
	Seattle University	Seattle
	Shoreline Community College	Seattle
	Skagit Valley College	Mount Vernon
	Tacoma Community College	Tacoma
	University of Puget Sound	Tacoma
	Walla Wella College	College Place
	Walla Walla Community College	Walla Walla
	Washington State Community College-District 5	
	Edmonds Community College	Lynnwood
	Everett Community College	Everett
	Washington State Community College-District 17	
	Spokane Falls Community College	Spokane
	Washington State University	Pullman
	Wenatchee Valley College	Wenatchee
	Western Washington State College	Bellingham
	Whatcom Community College	Bellingham
	Whitman College	Walla Walla
	Whitworth College	Spokane
	Yakima Valley College	Yakima
WV	Alderson Broaddus College	Phillippi
	Beckley College	Beckley
	Bethany College	Bethany
	Bluefield State College	Bluefield
	Concord College	Athens
	Davis and Elkins College	Elkins
	Glenville State College	Glenville
	Marshall University	Huntington
	Morris Harvey College	Charleston
	Parkersburg Community College	Parkersburg
	Potomac State College	Keyser
	Salem College	Salem
	West Liberty State College	West Liberty
	West Virginia Institute of Technology	Montgomery
	West Virginia University	Morgantown
	Wheeling College	Wheeling
WI	Alverno College	Milwaukee
	Beloit College	Beloit
	Blackhawk Technical Institute	Janesville
	Cardinal Stritch College	Milwaukee
	Carroll College	Waukesha
	Carthage College	Kenosha
	Concordia College	Milwaukee
	District One Technical Institute	Eau Claire
	Edgewood College	Madison
	Fox Valley Technical Institute	Appleton
	Gateway Technical Institute	Kenosha
	Holy Redeemer College	Waterford
	Institute of Paper Chemistry	Appleton
	Lakeshore Technical Institute	Cleveland
	Lawrence University	Appleton
	Madison Area Technical College	Madison
	Madison Business College	Madison
	Marian College of Fond Du Lac	Fond Du Lac
	Marquette University	Milwaukee
	Mid-State Technical Institute	Wisconsin Rapids
	Milton College	Milton

APPENDIX V

CATALOGS REVIEWED

STATE	INSTITUTION	LOCATION
	Milwaukee Area Technical College	Milwaukee
	Moraine Park Vocational, Technical and Adult Education Institute	Fond Du Lac
	Mount Mary College	Milwaukee
	Mount Senario College	Ladysmith
	Nicolet College and Technical Institute	Rhinelander
	North Central Technical Institute	Wausau
	Northeast Wisconsin Technical Institute	Green Bay
	Northland College	Ashland
	Ripon College	Ripon
	Saint Norbert College	De Pere
	Silver Lake College	Manitowoc
	Southwest Wisconsin Vocational-Technical Institute	Fennimore
	University of Wisconsin-Green Bay	Green Bay
	University of Wisconsin-Madison	Madison
	University of Wisconsin-Milwaukee	Milwaukee
	University of Wisconsin-System Office	Madison
	Viterbo College	La Crosse
	Waukesha County Technical Institute	Pewaukee
	Western Wisconsin Technical Institute	La Crosse
WY	Casper College	Casper
	Eastern Wyoming College	Torrington
	Laramie County Community College	Cheyenne
	Northwest Community College	Powell
	Sheridan College	Sheridan
	University of Wyoming	Laramie
	Western Wyoming Community College	Rock Springs